



NEWFOUNDLAND AND LABRADOR

DEPARTMENT OF ENVIRONMENT

**WATER RESOURCES
REPORT 2 - 2
GROUNDWATER SERIES**

**HYDROGEOLOGY
OF
THE NOTRE DAME BAY AREA**

**BY
HYDROLOGY CONSULTANTS LIMITED
MISSISSAUGA, ONTARIO
1980**

**DEPARTMENT OF ENVIRONMENT
WATER RESOURCES DIVISION
ST. JOHN'S, NEWFOUNDLAND**

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ABSTRACT

Groundwater is obtained from the overburden and the bedrock throughout the study area, in quantities generally adequate to meet domestic water requirements. Mean yields from the defined hydrogeologic units range from about 10 l/min for wells completed in the igneous rocks, to about 18 l/min for wells completed in the metamorphic and sedimentary rocks, and about 25 l/min for wells completed in granular overburden sediments. About one-third of the drilled wells fail to intercept adequate water indicating that the water-bearing zones are heterogeneous and sporadic in distribution. Less than ten percent of the drilled wells yield greater than 50 l/min, and the potential for developing high-capacity wells is considered poor. Most incorporated municipalities are serviced by surface-water systems, due to insufficient water supply or poor water quality.

The groundwater is chemically suitable for domestic use, with the local exception of iron and manganese. Salt-water intrusion has not been detected in coastal wells but is definitely possible where large groundwater withdrawals occur, considering the limited recharge potential and contributing areas.

The groundwater availability cannot be defined by conventional streamflow analyses, due to the moderating influence of the bogs and swamps on the surface runoff. Recharge is deduced from the physical nature of the aquifers to be about 50 mm annually. Detailed study of the storage variations in the main aquifer systems will be required to substantiate the groundwater recharge

The susceptibility of the aquifers to pollution ranges from moderate in the thick drift upland areas to high in the thin overburden or bedrock areas, occurring in the coastal zones where many of the smaller communities are located.

1.0 INTRODUCTION

1.1 Scope of Study

This study was undertaken by Hydrology Consultants Limited, consistent with the guidelines provided by the Department of Consumer Affairs and Environment, Province of Newfoundland and Labrador.

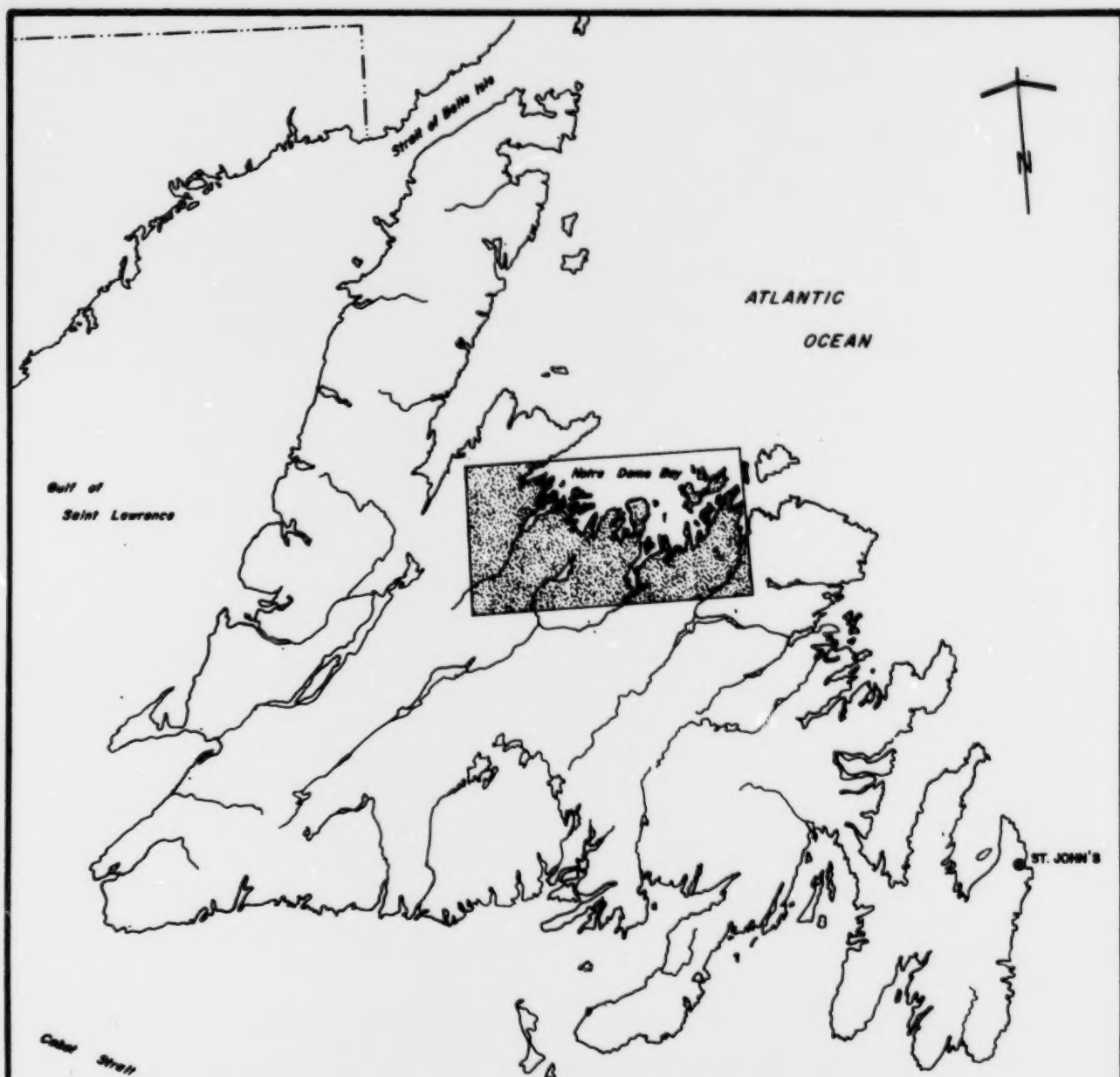
The essential objectives of the study were to define the hydrogeologic characteristics of the surficial and bedrock formations; to map the distribution of the defined hydrogeologic units; to interpret the availability of groundwater recharge from climatic and streamflow information; and to determine potential aquifer-pollution sources, related to natural and man-made effects.

1.2 Location

The study area comprises the area north of the 49 degree latitude to the Notre Dame Bay coastline and adjacent islands, and from Southwest Arm-Green Bay to Gander Bay, between 54° 30' and 56° 30' west longitudes, as outlined on Figure 1.1

1.3 Previous Work

A joint water resources report carried out for the Atlantic Development Board by Shawinigan Engineering Company Limited and James F. MacLaren Limited included the two major basins, namely the Exploits and the Gander river systems, and provided the essential background data of this study.



GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
HYDROGEOLOGIC STUDY OF THE NOTRE DAME AREA

LOCATION AND EXTENT OF STUDY AREA



HYDROLOGY CONSULTANTS LIMITED
CONSULTING ENGINEERS AND GEOLOGISTS

Job No.	8513	Scale	1:3 100 000
Drawn by	JS	Date	March, 1980
Appr. by	LS		
Reviewed			FIGURE 1.1

Geologic information was obtained from published and unpublished reports, and open files of the Department of Mines and Energy, and the Department of Forestry and Agriculture. Water well information was assembled from the files and reports of the Department of Consumer Affairs and Environment. Stream-flow and precipitation data were obtained from publications of Environment Canada.

1.4 Acknowledgements

Appreciation is extended to the following persons for the assistance provided in the compilation and interpretation of the hydrogeologic information presented in this report.

Mr. W. Ullah - Department of Consumer Affairs and Environment
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Mr. G. Parsons - Department of Transportation and Communication
Mr. J. Vandel Hulst - Department of Rural, Agricultural and
Northern Development

2.0 GEOGRAPHY

2.1 Physiography and Topography

The study area essentially lies within the Newfoundland Central Lowlands, except for the western extremity, which occurs within the Newfoundland Highlands, as illustrated in Figure 2.1. The topography is largely controlled by the bedrock geology, with the resistant rocks forming the highland areas and the less resistant rocks forming the lowlands.

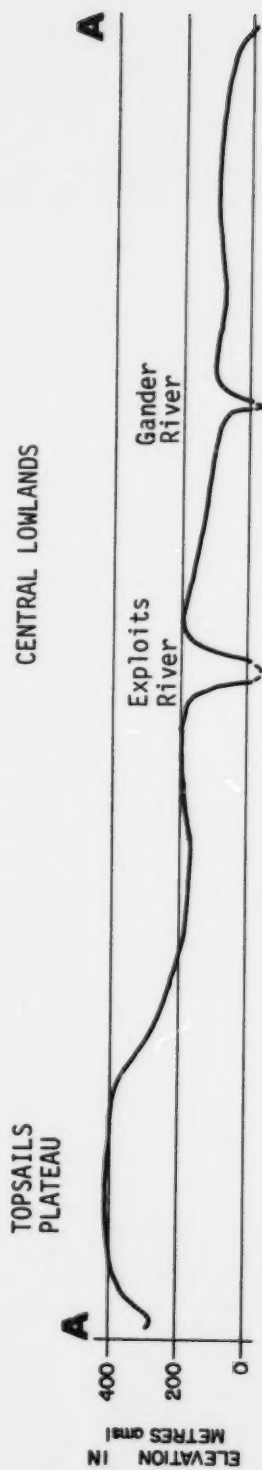
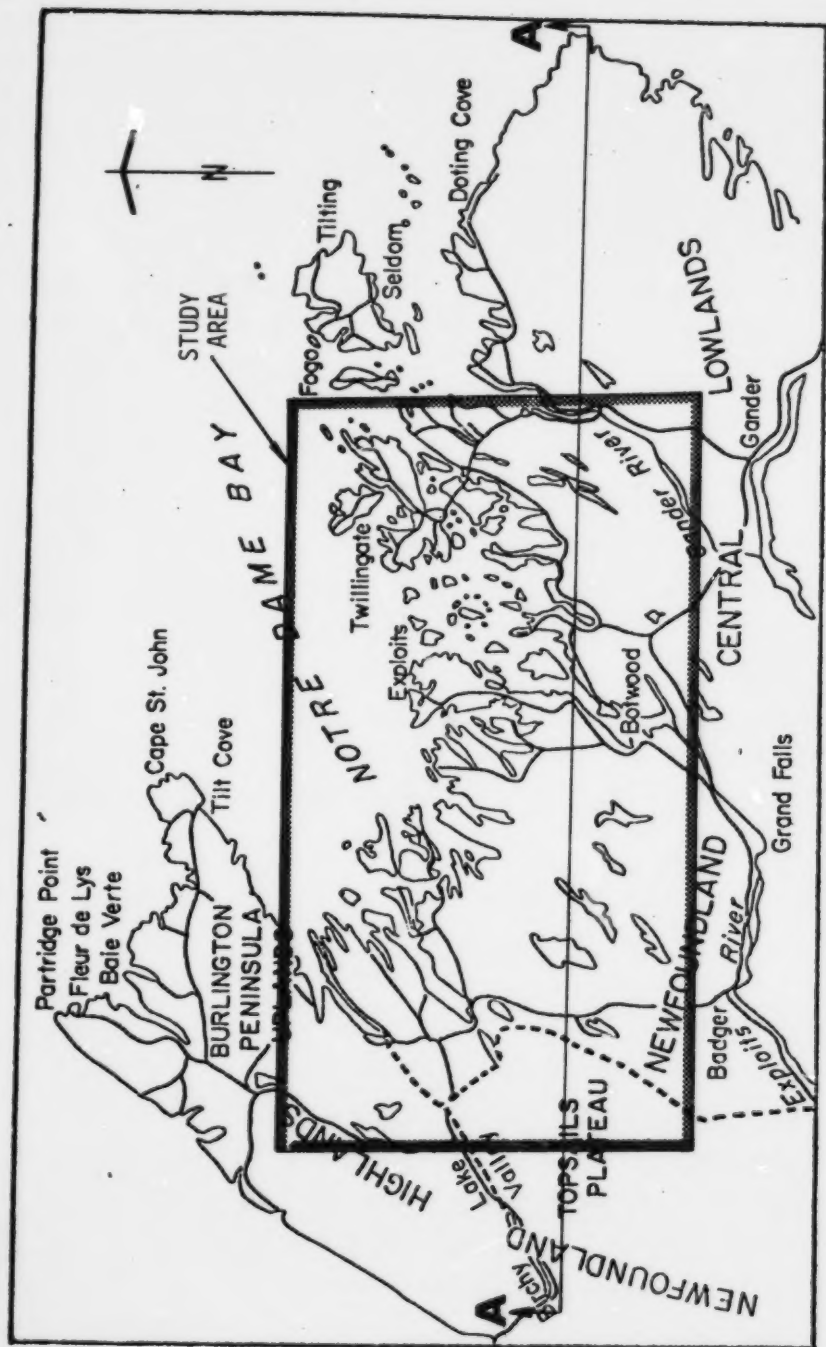


FIGURE 2.1 Major Physiographic Subdivisions of Notre Dame Bay Area

Within the Newfoundland Central Lowlands, the land surface is generally less than 150 metres ASL in elevation, excepting for local ridges and the west-central uplands, which range up to 300 metres ASL. The ridges commonly comprises steeply-dipping, resistant volcanic rocks, whereas the uplands are largely underlain by intrusive and plutonic rocks.

The Newfoundland Highlands comprise the Topsails Plateau and the Burlington Peninsula Uplands, which are separated by the Green Bay Fault System. Within the Topsails Plateau, the land surface rises gradually up from the fault zone to an extensive, rolling plateau at an elevation above 300 metres ASL. Within the Burlington Peninsula Uplands, the land surface rises sharply from the fault zone to an irregular upland at an elevation above 300 metres ASL.

The surficial characteristics of the study area are substantially similar to those of the major rivers discharging to Notre Dame Bay, which are typified in Table 2.1 and indicate a significant percentage of lake and swamp areas.

2.2 Drainage

Due to tilting of the Central Newfoundland plateau, large drainage basins were formed with drainage towards Notre Dame Bay.

The drainage pattern was developed by erosion along the major fault zones, which trend in a northeastward direction. Although the land surface was subsequently modified by ice scour and drift deposition, the drainage pattern was largely unchanged, resulting in the development of the extensive lake-swamp environment.

TABLE 2.1

SURFICIAL CHARACTERISTICS OF RIVER BASINS

<u>Basin</u>	<u>Basin Area (sq. km)</u>	<u>Lake Area (sq. km)</u>	<u>Forest Area (sq. km)</u>	<u>Swamp Area (sq. km)</u>
EXPLOITS - BAY OF EXPLOITS	12808	1067	7998	2095
EXPLOITS - GRAND FALLS	9484	911	5509	1818
GANDER - GANDER BAY	5372	361	4078	489
GANDER - BIG CHUTE	4350	284	3216	428
INDIAN BROOK - INDIAN FALLS	982	79	744	60

2.3 Climate

2.3.1 General

The Notre Dame Bay area occurs within a cool and humid climatic region, having a mean annual temperature of about 4°C, and a mean annual precipitation of about 1000 mm.

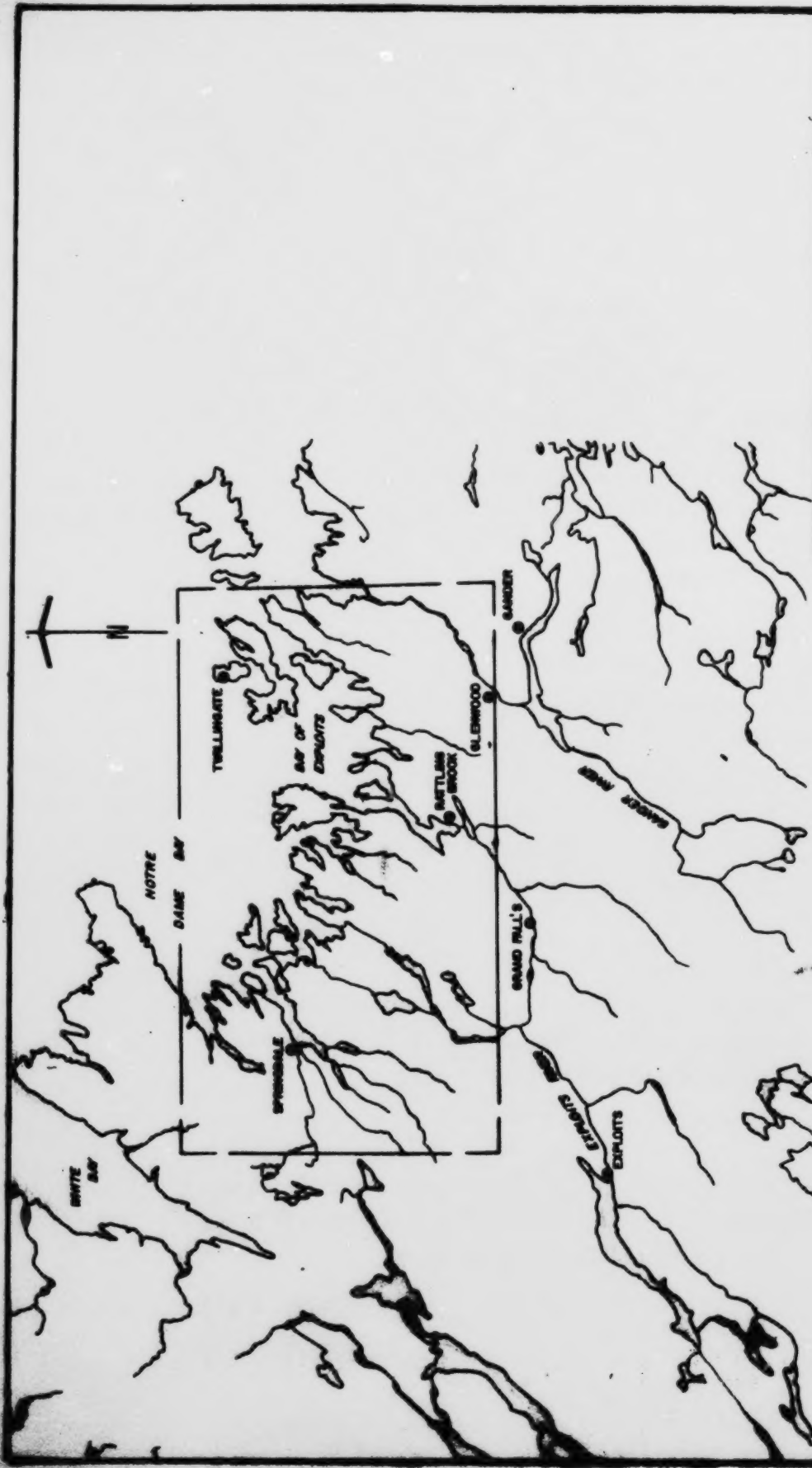
The annual evaporation, calculated by the Atmospheric Environment Service is about 530 mm, indicating that a large water surplus is available as runoff.

2.3.2 Precipitation

Table 2.2 summarizes the monthly precipitation recorded at the seven precipitation stations situated adjacent to and within the study area, as shown in Figure 2.2. The precipitation is shown to generally vary from over 1000 mm for the upland stations to about 950 mm for stations in the coastline areas. Generally, the precipitation is fairly substantial during each month, being lowest in late spring (May) and highest in the late fall (November).

2.3.3 Temperature

As shown on Table 2.3, the mean daily temperature varies from about 3.3°C (38.0°F) at Exploits Dam, representative of the upland area, to 4.9°C (40.9°F) at Rattling Brook, representative of the lowlands. The temperatures are highest during July, and decrease gradually to the lowest values during February.



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Locations of Regional
Precipitation Stations

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Reviewed			

Figure 2.2

TABLE 2.2

MEAN PRECIPITATION (millimetres)

<u>Location</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sep.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Year</u>	<u>Type of Normal</u>
Exploits Dam	101.1	86.1	96.8	71.4	61.5	90.2	96.8	102.1	93.5	98.3	118.9	116.6	1133.3	5
Gander Int'l Airport	94.0	100.8	96.8	85.1	62.5	76.2	77.7	100.8	84.1	95.3	106.9	98.0	1078.2	1
Glenwood	86.6	90.4	82.0	69.9	63.8	73.7	69.9	101.9	81.0	94.5	97.3	84.6	995.3	1
Grand Falls	80.0	90.4	80.0	57.7	56.4	77.7	83.1	100.3	82.6	93.7	98.6	81.0	981.5	3
Rattling Brook-Norris Arm	115.8	102.4	132.6	91.9	71.1	77.2	71.6	106.7	74.9	93.7	115.6	113.0	1166.5	5
Springdale	91.2	84.1	78.0	46.7	57.7	73.7	69.1	105.4	81.3	91.2	91.2	91.2	960.8	4
Twillingate	95.3	93.7	84.8	63.5	52.8	66.5	67.3	82.0	68.8	86.6	85.6	87.1	934.0	4

Type of Normal Code:

- 1 - 30 years or more between 1941 and 1970
- 2 - 25 to 29 years between 1941 and 1970
- 3 - 20 to 24 years between 1941 and 1970
- 4 - 15 to 19 years between 1941 and 1970
- 5 - 10 to 14 years between 1941 and 1970

TABLE 2.3

MEAN DAILY TEMPERATURE ($^{\circ}\text{C}$)

<u>Station</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Mean Annual</u>
Exploits Arm	-7.0	-8.3	-4.7	0.0	5.6	10.6	15.0	14.8	10.3	5.7	1.7	-3.9	3.3
Gander Int'l Airport	-6.1	-6.3	-3.6	0.8	6.3	11.4	16.5	15.8	11.8	6.3	1.9	-3.4	4.3
Glenwood	-6.1	-6.3	-3.3	1.5	6.8	11.6	16.4	15.8	11.5	6.3	2.2	-3.4	4.4
Grand Falls	-6.6	-6.5	-3.3	1.4	7.2	11.9	17.1	16.3	12.0	6.7	2.3	-3.4	4.6
Rattling Brook-Norris Arm	-6.0	-6.7	-3.1	1.3	7.1	12.6	17.5	16.7	12.0	7.2	3.0	-2.6	4.9

2.3.4 Evapotranspiration

Calculations have been made by the Atmospheric Environment Service for two climatological stations near the study area to evaluate the potential evapotranspiration, the amount of water that would evaporate and transpire with optimum water availability, and the actual evapotranspiration, the amount of water actually evaporated and transpired dependent on the seasonal availability of precipitation and soil moisture. Table 2.4 illustrates the monthly potential and actual evapotranspiration, assuming the initial availability of 100 mm of soil moisture.

These data illustrate the abundant seasonal availability of water, with soil moisture depletion occurring only during the period extending from June to August.

3.0 HYDROLOGY

3.1 General

The Notre Dame Bay area includes two major river basins, the Gander and the Exploits, having total areas of about 5200 and 11400 square kilometres, respectively, and three smaller basins, being the Barney Brook and Indian Brook and Deer Lake systems. The areal extent and locations of the various basins are provided in Figure 3.1 and in Table 3.1.

3.2 River Discharges

Monthly and annual discharges of the river basins are provided in Table 3.2, and indicate that the maximum mean monthly flows occur in May, and the minimum mean monthly flows occur in July and August. The locations of the streamflow gauging stations are shown on Figure 3.2.

TABLE 2.4

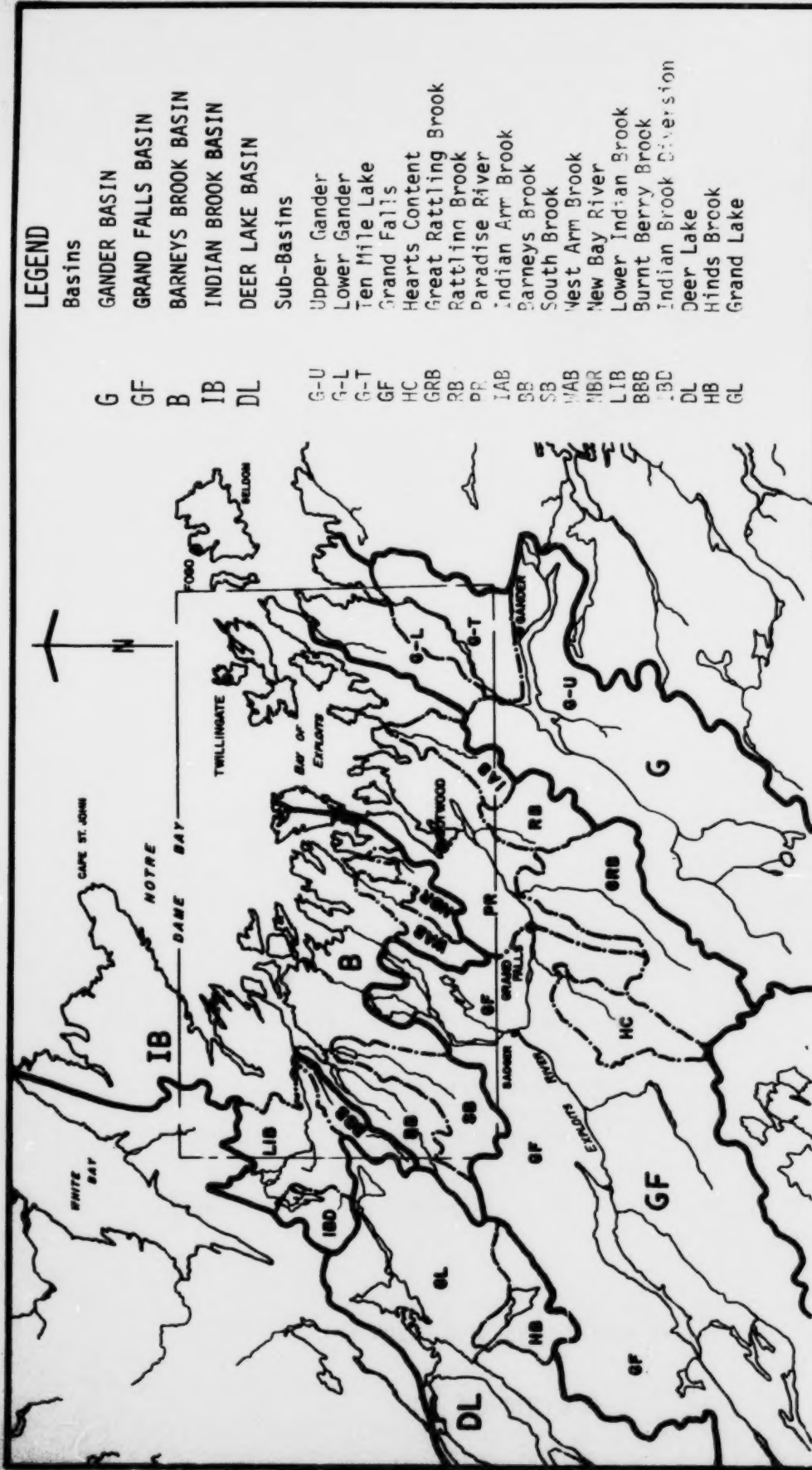
POTENTIAL AND ACTUAL EVAPOTRANSPIRATION (millimetres)

<u>Station</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Annual</u>
<u>Gander Int'l Airport</u>													
Potential Evapotranspiration	0	0	0	9	60	91	133	112	72	43	12	0	531
Actual Evapotranspiration	0	0	0	9	60	90	114	106	72	43	12	0	505
<u>Grand Falls</u>													
Potential Evapotranspiration	0	0	0	17	60	101	133	122	80	43	12	0	567
Actual Evapotranspiration	0	0	0	17	60	98	113	109	80	43	12	0	532

TABLE 3.1

NOTRE DAME BAY - RIVER BASINS

<u>Basin</u>	<u>Sub-Basin</u>	<u>Area</u>	
		<u>sq. km.</u>	<u>sq. miles</u>
Gander (G)	Upper Gander (G-U)	4377.08	1,690
	Lower Gander (G-L)	813.26	314
	Ten Mile Lake (G-T)	370.37	143
Grand Falls (GF)	Grandfalls (GF)	7832.13	3,024
	Hearts Content (HC)	90.65	35
	Great Rattling Brook (GRB)	1458.16	563
	Rattling Brook	378.14	146
	Indian Arm Brook (IAB)	308.21	119
Barneys Brook (B)	Barneys Brook (BB)	512.82	198
	South Brook (SB)	631.96	244
	West Arm Brook (WAB)	261.59	101
	New Bay River (NBR)	217.56	84
Indian Brook (IB)	Lower Indian Brook (LIB)	735.56	284
	Burnt Berry Brook (BBB)	207.20	80
	Indian Brook Diversion (IBD)	238.28	92
Deer Lake (DL)	Deer Lake (DL)	3444.69	1,330
	Hinds Brook (HB)	518.00	200
	Grand Lake (GL)	Not Available	N.A.



LEGEND

- Basins
- G GANDER BASIN
 - GF GRAND FALLS BASIN
 - B BARNEYS BROOK BASIN
 - IB INDIAN BROOK BASIN
 - DL DEER LAKE BASIN
- Sub-Basins
- G-U Upper Gander
 - G-L Lower Gander
 - G-T Ten Mile Lake
 - GF Grand Falls
 - HC Hearts Content
 - GRB Great Rattling Brook
 - RB Rattling Brook
 - PR Paradise River
 - IAB Indian Arm Brook
 - SB Parneys Brook
 - SB South Brook
 - VAB West Arm Brook
 - MBR New Bay River
 - LIB Lower Indian Brook
 - BBR Burnt Berry Brook
 - BCB Indian Brook Diversion
 - DL Deer Lake
 - HB Hinds Brook
 - GL Grand Lake

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
HYDROGEOLOGIC STUDY OF THE NOTRE DAME AREA

River Basins

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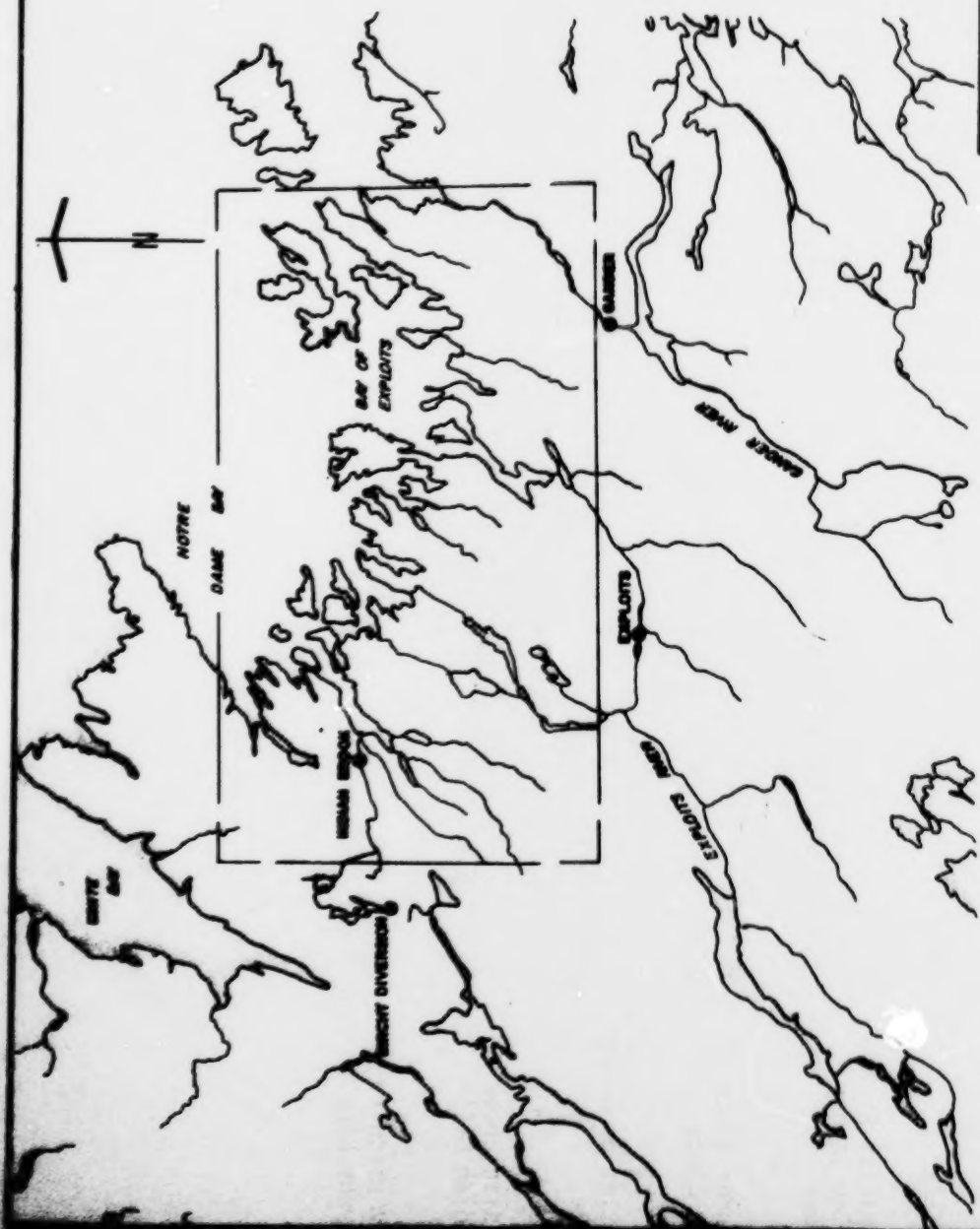
Figure 3.1

TABLE 3.2

RIVER BASINS MEAN DISCHARGE

Monthly and Annual Discharge (cubic metres/second)

<u>Station</u>	<u>Jan.</u>	<u>Feb.</u>	<u>Mar.</u>	<u>Apr.</u>	<u>May.</u>	<u>June</u>	<u>July</u>	<u>Aug.</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Mean</u>	<u>Year</u>
Exploits River below Stoney River	216.4	242.5	226.4	362.2	458.5	262.6	196.1	193.8	195.8	242.5	258.4	288.7	262.1	1969-1976
Gander River at Big Chute	103.6	94.0	97.1	213.7	273.9	106.7	53.5	46.7	49.8	83.2	144.6	143.2	129.1	1949-1976
Outlet of Gander Lake	85.8	71.0	93.7	240.3	283.0	97.3	67.3	34.5	45.6	110.9	134.1	131.6	116.6	1923-1939
Indian Brook at Indian Falls	15.3	9.6	11.7	28.6	69.3	25.3	8.7	7.2	8.2	14.8	20.9	18.8	20.0	1954-1976
Diversion to Birchy Lake	3.2	2.8	3.0	8.9	17.9	6.3	2.6	2.5	2.3	4.5	6.3	5.4	5.5	1963-1976



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HYDROGEOLOGIC STUDY OF THE NOTRE DAME AREA

Locations of Regional
Streamflow Gauging Stations

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FIGURE 3.2

3.3 Water Budget

The hydrologic budget of a river basin may be expressed by the following equation:

$$P = RO + ET + S$$

where P = Precipitation

RO = Runoff

ET = Evapotranspiration

S = Basin storage (soil, surface, groundwater)

On a long-term basis, the basin storage changes may be neglected, and the equation is further simplified to

$$P = RO + ET$$

Long-term mean basin yields for the major river basins in the study area are listed in Table 3.3 . A wide variation in the mean yield is evident with the yield of the Exploits River being about 50 percent larger than that of Indian Brook.

From these mean yields and the calculated evapotranspiration for the immediate study area, an indication may be obtained of the contributing precipitation, with the following results.

<u>Basin</u>	<u>RO(mm)</u>	<u>ET(mm)</u>	<u>Total RO+ET(mm) or P(mm)</u>
Exploits - Stoney Brook	960	530	1490
Gander - Big Chute	845	530	1375
Indian Brook - Indian Falls	645	530	1175

The nearest precipitation station to the Indian Brook basin occurs at Springdale and has a mean annual rainfall

of about 960 mm, or 215 mm less than that calculated from the hydrologic budget. This discrepancy is believed attributable to the larger contribution of precipitation in the upper basin, which reportedly exceeds 1200 mm.

Similarly, for the Exploits and Gander rivers, the hydrologic budget indicates that the contribution of precipitation in the upper basins is substantially larger than that of the lower basins and/or the evapotranspiration is smaller in order to balance the hydrologic equation. Greater rainfall is indicated in the upper basins, exceeding 1300 mm, whereas the evapotranspiration is reportedly somewhat smaller, about 400 mm.

4.0 GEOLOGY

4.1 Surficial Geology

Extensive glaciation occurred during the Wisconsinan phase of Pleistocene glaciation, with ice movement being largely northward toward the coast, being predominantly controlled by the pre-Pleistocene bedrock topography.

Much of the study area is blanketed by glacial till, being thickest, and continuous in the upland areas, and thinning towards the coastline. The large inland valleys generally acted as glaciofluvial spillways during the melting of the ice sheets and are commonly filled with thick outwash deposits. Glacial-origin deltas are common near the heads of the larger bays, such as the Bay of Exploits.

Map 1 illustrates the distribution of the main overburden deposits, and the reported thickness of the sediments determined from the well reports.

4.2 Bedrock Geology

The study area is situated within the Appalachian Mobile Belt, which has been subjected to considerable tectonic activity and the intrusion of plutonic rocks. Consequently, the rocks, primarily sedimentary and volcanic rocks, have undergone various degrees of metamorphism, primarily during the Acadian orogeny.

Map 2 illustrates the general complexity of the patterns and the various bedrock formations, as determined by several investigations.

5.0 HYDROGEOLOGY

5.1 Introduction

The hydrogeologic information presented in this report has been obtained entirely from the water-well records provided in the provincial publications. Appendix A provides a tabular summary of the well records categorized according to the formations in which the wells terminate. No specific consultant or provincial reports were available pertaining to the hydrogeologic characteristics of the Notre Dame Bay area.

Water-wells are not numerous and are largely situated in the coastal areas, where many of the communities occur. In total, 339 wells were located within the study area, of which 25 wells penetrate into igneous rocks, 165 wells into the sedimentary rocks, 135 wells into the volcanic rocks, and 24 wells into the overburden deposits.

The data provided in the well records are sparse, mainly comprising information on the well depth, yield, overburden thickness and occasionally, water-level depth. Lithologic logs and pumping-test results are essentially absent, necessitating the utilization of the bedrock geology information to define the units in which the wells are completed, and limiting the hydrogeologic assessment of the various formations to a statistical analysis of the reported well yields and depths.

The aquifer yield evaluation was premised on the driller's reports, although the well-testing was likely undertaken by bailing or air compression, under which conditions discharge control cannot be assured.

Consequently, there may be a wide variation between the reported yields and actual yields, and more importantly, between the reported yields and the perennial yields, which can only be assessed from knowledge of the aquifer setting and pumping response. Nevertheless, recognizing that the testing procedures are similar throughout the study area, a comparative evaluation of the well yields to determine the general yield characteristics of the defined hydrogeologic units remain valid.

5.2 Hydrogeologic Units

The occurrence, movement and availability of groundwater is controlled by the lithologic nature and structure of the materials present in the Notre Dame Bay area, namely the unconsolidated surficial sediments, largely comprising glacial till and granular outwash and fluvial deposits, and the underlying bedrock, comprising the various volcanic, sedimentary, metamorphic and igneous formations.

Where water moves through a formation in a quantity sufficient for a given need, the water-bearing formation is defined as an aquifer. The sustained productivity of aquifers may vary widely, dependent on the number and degree of interconnection of openings which serves as conduits for groundwater flow, the areal extent and depth of the aquifer, and the availability of recharge to the aquifers.

The basic classification of the hydrogeologic units has been made on the basis of groundwater flow through the various formations. Within the surficial sediments, groundwater is stored and moves entirely through intergranular pore spaces, whereas, within the bedrock formations, groundwater storage and movement is largely dependent on the degree and distribution of the faults and fracture planes, as the intergranular porosity was largely destroyed by metamorphism. Typically, the surficial sediments have appreciably larger storage capacity than that of the bedrock formations, but may not yield larger groundwater supplies unless the voids are relatively large and interconnected, as within coarse-grained deposits, such as sand and gravel.

5.2.1 Surficial Units

The study area is extensively mantled with unconsolidated sediments deposited by ice sheets and associated meltwaters. Where present beneath the water table, these deposits comprise potential water-yielding formations.

Four overburden hydrogeologic units have been defined on the basis of thickness, composition and water-yielding characteristics. Their distributions are shown on Map 1.

Unit 1 represents thin glacial drift, largely consisting of sandy silt till less than 4.5 m (15 ft) in thickness. Distribution of the unit within the study area is widespread, being mainly along the coastline and adjacent islands. The low permeability and limited saturated thickness of the unit severely restricts the available groundwater supply, and development may only be undertaken by large-diameter dug or bored wells. Individual well yields vary according to the local till composition and the presence of granular seams or interbeds, but typically the potential is low, being about 0 to 15 l/min (0 to 3 gpm). Availability is controlled by the water-table depth and formation thickness and the formation may be best developed by dug and bored wells, which have a large storage capacity and preclude the requirement for rapid inflow of groundwater to the well bore.

Unit 2 comprises glacial drift, largely consisting of sandy silt till, in the form of ground and ablation moraines with sporadic interbeds of granular materials. The unit is substantially thicker than Unit 1, possibly about 45 to 60 m (150 to 200 ft) locally. This formation is widely distributed and covers much of the southerly study area. Overburden wells drilled in the communities situated within or adjacent to this formation report moderate yields of about 15 to 25 l/min (3 to 5 gpm); however, as many of these communities are also located in low-relief areas where granular outwash material occur, it is not possible to confirm that any well appropriately represents the glacial till unit. The yield potential is considered to vary from about low to moderate or from 0 to 45 l/min (0 to 10 gpm) for drilled wells,

dependent on the depth, thickness and composition of the granular interbeds. Where such granular materials are absent, low yields up to 15 l/min (3 gpm) should remain obtainable from the unit, by installation of large-diameter wells to take advantage of the well-bore storage capacity.

Unit 3 comprises stratified sand and gravel, namely in the form of surficial outwash and deltaic, glaciofluvial and kame materials deposited by glacial meltwaters during the retreat of the major ice sheets. The distribution of the granular deposits is largely confined to the major river valleys, being Indian Brook, the Exploits River, Indian Arm Brook and the Grand River. Locally, these deposits have substantial thickness ranging from about 9 m (30 ft) to about 27 m (90 ft), as intercepted by the drilled wells in the Exploits River Basin.

Twenty-four wells were located within the study area appear to be completed in the surficial granular deposit, Unit 3, according to the well-depth and overburden-thickness information. Available well data are summarized in the following table.

<u>Number of Wells</u>	<u>Mean Yield- Producing Wells(l/min)</u>	<u>Median Yield- Producing Wells(l/min)</u>	<u>Mean Well Depth (m)</u>	<u>Percentage Dry Wells</u>	<u>Percentage Wells Producing 50 l/min or more</u>
24	24.3	22.5	14.0	37	5

These wells are mainly located in four communities; Springdale, Norris Arm, Port Leamington and Notre Dame Junction, and exhibit similar yield characteristics.

Only one of the overburden wells is reported to supply more than 50 l/min (11 gpm), which is considered the lower yield limit for a well serving a small community.

Recognizing that the drilled wells are not equipped with well screens, limiting the entrance of groundwater to the open-end well bore, the contributing water-bearing zone may not reflect the actual potential of the aquifer to yield groundwater supplies, and the available yields may be significantly larger than indicated by the well records.

Appreciably larger supplies would be expected in the thick saturated granular deposits, particularly adjacent to the major rivers, as at Bishop's Falls, where the town obtained about 1300 cu m/day (0.3 mgd) for residential and industrial uses, from two shallow infiltration wells. Subsequently, due to chemical quality problems, the wells were abandoned in favour of a surface-water supply.

The large percentage of wells reportedly dry or yielding negligible supplies is significant, and may indicate wide variability in the lithology of the stratified sediments. These negative wells are essentially located in the Norris Arm and Port Leamington areas, and may reflect local, low-yield potential; however, this cannot be confirmed with the available well data.

Unit 4 comprises the recent marsh and bog deposits which are widely distributed throughout the study area. This unit has been subdivided to map the distribution of the under-

lying surficial deposits as Unit 4-1, overlying the glacio-fluvial sediments in the lowland areas, and as Unit 4-2 overlying the till in the highland and plateau areas.

These deposits are generally thin and fine-grained in composition and have no potential of yielding groundwater supplies but are significant features, considering the possible effects on groundwater quality due to their high organic content and the runoff distribution due to their inherent storage capacity.

5.2.2 Bedrock Units

The volcanic and sedimentary rocks in the study area, being situated within the mobile belt, have been subjected to metamorphism. Joints, fractures and faults were widely developed within the rocks, as evidenced by the distribution of the major faults shown on Map 2, and provide the main conduits for groundwater movement.

Essentially, the water-yielding and storage characteristics of the various rock units in the Notre Dame Bay area are similar, being dependent on the degree and distribution of the secondary permeability. However, four units were identified in an effort to differentiate the hydraulic properties of the major petrological formations, these being the igneous plutonic rocks, the volcanic rocks, the moderately metamorphosed sedimentary rocks, and the highly metamorphosed rocks, without emphasis on the age of deposition or intrusion.

Igneous Rock Unit

This unit comprises all of the plutonic rocks, ranging in age from Ordovician to Devonian, and includes major granite, granodiorite, diabase and diorite intrusions in the South Twin Lake-Mary Ann Lake area, and south of the Bay of Exploits; a granite-granodiorite intrusion extending from Long Island to Loon Bay; and a granodiorite-gabbro intrusion in the Twillingate area.

Twenty-five wells were located within the plutonic rock unit, primarily in the easterly study area of Twillingate, Durrell and Birchy Bay. Yield characteristics of the formation according to the well reports are summarized in the following table.

<u>Number of Wells</u>	<u>Mean Yield-Producing Wells(l/min)</u>	<u>Median Yield-Producing Wells(l/min)</u>	<u>Mean Well Depth (m)</u>	<u>Percentage Dry Wells</u>	<u>Percentage Wells Producing 50 l/min or more</u>
25	20.3	9.0	42.1	35	8

These data emphasize the low yield potential of the igneous rocks, with the majority of wells supplying less than 10 l/min (2 gpm), with fairly deep penetration of the formation. Few wells provide 50 l/min (11 gpm) or larger yields, indicating that considerable drilling would be required to obtain a moderate-yield well. The wells exhibiting the largest yields, ranging up to 90 l/min (20 gpm) are generally less than 30 m (100 ft) in depth, suggesting that the main fracture systems in the plutonic rocks may generally occur at shallow depth.

Volcanic Rock Unit

This unit comprises the relatively unmetamorphosed volcanic rocks; essentially consisting of basic pillow lava, flows, breccia and tuff, with major sedimentary rocks, mainly ranging in age from Ordovician to Silurian. Volcanic rocks predominate throughout the northwesterly study area and in a broad band including the outer peninsulas and islands extending from Little Bay Island to North Twillingate Island.

Extensive faulting has placed several volcanic formations together, and support the interpretation of a common hydrogeologic unit. However, to evaluate the possibility of variable yield capabilities, the bedrock formations were initially reviewed as separate entities, and these data were subsequently combined to determine the regional characteristics of the volcanic rock unit. Table 5.1 illustrates the specific well yield and depth characteristics for the main developed rock formations, and the combined values for the volcanic sequence within the study area.

From these data, the volcanic rock unit is evaluated to have a moderate yield potential, of about 18 l/min (4 gpm) for the wells intercepting water-bearing fractures. Significantly, about one-third of all wells drilled in the unit are reported to be dry or to yield negligible water supplies, whereas only 7 percent of all completed wells yield supplies exceeding 50 l/min (11 gpm). Discernable trends were not apparent in the yield-depth relationships within the volcanic unit. Yields of wells completed in the 30 m (100 ft) range are commonly similar to those of wells in the 60 m (200 ft) range,

TABLE 5.1

VOLCANIC ROCK UNIT - WELL SUMMARY

<u>Formation/Group</u>	<u>Number of Wells</u>	<u>Mean Yield -Producing Wells (l/min)</u>	<u>Median Yield -Producing Wells (l/min)</u>	<u>Mean Well Depth (m)</u>	<u>Percentage Dry wells</u>	<u>Percentage Wells Producing 50 l/min or Greater</u>
Lush's Bight	55	27.0	18.0	46.6	35	11
Cutwell	25	41.9	22.5	59.7	20	16
Robert's Arm	21	18.9	22.5	43.0	29	5
Exploits	21	23.4	18.0	32.3	38	5
Moreton's Harbour	13	34.2	4.5	40.8	62	8
Total Volcanic Sequence	135	28.8	18.0	45.7	34	7

indicating that much of the groundwater is obtained from the shallow fracture systems or that the deep fractures are small or absent.

Overall, the Cutwell Group, essentially found in the vicinity of Little Bay Island and Long Island, exhibits the best groundwater potential of the developed volcanic formations, with 16 percent of the wells yielding at least 50 l/min (11 gpm) and only 20 percent of the wells being dry; however, the average well is about 30 percent deeper than that of the combined volcanic unit. The largest reported yield is 270 l/min (60 gpm) from a 170 foot well drilled on Little Island.

The adjacent Moreton's Harbour Group, essentially comprising the upper Fortune Arm and Moreton's Harbour peninsulas, Exploits Islands and Black Island, has the lowest yield potential, providing an average 5 l/min (1 gpm) to the producing wells, and having about 60 percent of the wells abandoned due to insufficient supply. The highest yield well is reported to be at a Moreton's Harbour school, supplying 160 l/min (35 gpm).

The Lush's Bight and Robert's Arm formations comprising the area adjacent to Halls Bay, have yield characteristics similar to the total volcanic hydrogeologic unit, with producing wells providing about 18 to 22 l/min (4 to 5 gpm) and having depths of about 45 to 50 m (140 to 150 ft). Lower yields are locally obtained, generally less than 9 l/min (2 gpm) from wells exceeding 60 m (200 ft) at Port Anson and Pilley's Island. Larger yields of about 70 l/min (15 gpm) have been intercepted by several wells in the Beachside and Brighton Areas.

The Exploits Group, which essentially occurs as narrow bands in the lower Fortune Harbour peninsula and Loon Bay areas, yields about 18 l/min (4 gpm) from wells about 35 m (100 ft) in depth. Significantly, these are about 30 percent shallower than the typical volcanic well.

The Wild Bight Group is the volcanic formation with the largest areal distribution, extending south from Badger and Seal Bays; however, as much of the formation occurs inland, groundwater development has been limited, and available well data are not sufficient to fully appraise its potential. The few records indicate a wide yield range from 0 to over 50 l/min, and, considering the fracture and fault distributions, the formation is deduced to have a yield potential similar to that of the overall volcanic sequence. A similar interpretation applies to the Springdale volcanic formation, which extends southwesterly from Halls Bay.

Sedimentary Rock Unit

The sedimentary rock unit includes several moderately metamorphosed sedimentary formations, mainly of Ordovician to Silurian age, which comprise sandstone, siltstone, conglomerate, argillite, greywacke, with minor volcanic flows and tuff. Significantly, carbonate rocks are essentially absent in these formations. These formations are largely distributed in the easterly study area, extending from Point Leamington, the Bay of Exploits and Bishop's Falls.

Although the sedimentary formations form a common hydrogeologic unit, generally having the same lithologic composition, and exhibiting similar fracture patterns, the

initial interpretation of well data was based on the individual units to possibly identify significant yield characteristics.

Table 5.2 lists the major developed formations, according to well depth and yield, together with a summary of the total sedimentary rock sequence.

The sedimentary rock unit is a moderate water-yielding unit, providing about 15 l/min (3 gpm) to successfully completed wells, being about 43 m (140 ft) in average depth. Significantly, about one-third of all wells drilled in the sedimentary rock unit are reported to be dry, whereas only 9 percent of the wells have yields of 50 l/min (11 gpm) or greater. As with the volcanic rock unit, a trend could not be established between well yield and depth.

The various sedimentary rocks exhibit similar median yields from producing wells; being about 15 to 18 l/min (3 to 4 gpm) for each formation. The most notable variations are the depths of wells in the Exploits-Port Leamington unit which are about 50 percent deeper, averaging about 65 m (215 ft), than the typical sedimentary well depth, and the large percentage of dry wells in the Botwood formation, which comprises about one-half of all wells drilled in the formation. The high dry-well percentage results from the occurrence of many dry wells at one locality, near Norris Arm, and may relate to the fault distribution in the inland areas. The highest yield wells generally supply about 150 l/min (30 gpm) and have been drilled at several of the scattered communities.

TABLE 5.2

SEDIMENTARY ROCK UNIT - WELL SUMMARY

<u>Formation/Group</u>	<u>Number of Wells</u>	<u>Mean Yield -Producing Wells (l/min)</u>	<u>Median Yield -Producing Wells (l/min)</u>	<u>Mean Well Depth (m)</u>	<u>Percentage -Dry Wells</u>	<u>Percentage -Wells Producing 50 l/min or Greater</u>
Sansom	68	24.8	13.5	38.1	31	10
Exploits - Point Leamington	13	20.7	18.0	65.2	36	8
Botwood	42	31.1	13.5	38.4	48	10
Dunnage Melange	42	22.5	13.5	45.4	33	10
Total Sedimentary Sequence	165	24.8	13.5	43.0	36	9

Other prominent sedimentary groups not listed in Table 5.2, include the Springdale, Buchans, and Davidsville groups, for which few well records exist. Similar yield characteristics to the overall sedimentary unit would be anticipated based on the formation characteristics and fault distributions.

Metamorphic Rock Unit

Highly metamorphosed rocks, comprising schist, gneiss, quartzite and slate, with minor volcanic flows of Precambrian to Ordovician age occur in the extreme northwest and southeast parts of the study area.

No local wells are completed in these formations but, considering the degree of metamorphism and faulting and the apparent well yields outside the study area, the potential yield of the unit may be very variable, from 0 to 50 l/min (0 to 11 gpm).

5.3 Summary of Yield Characteristics

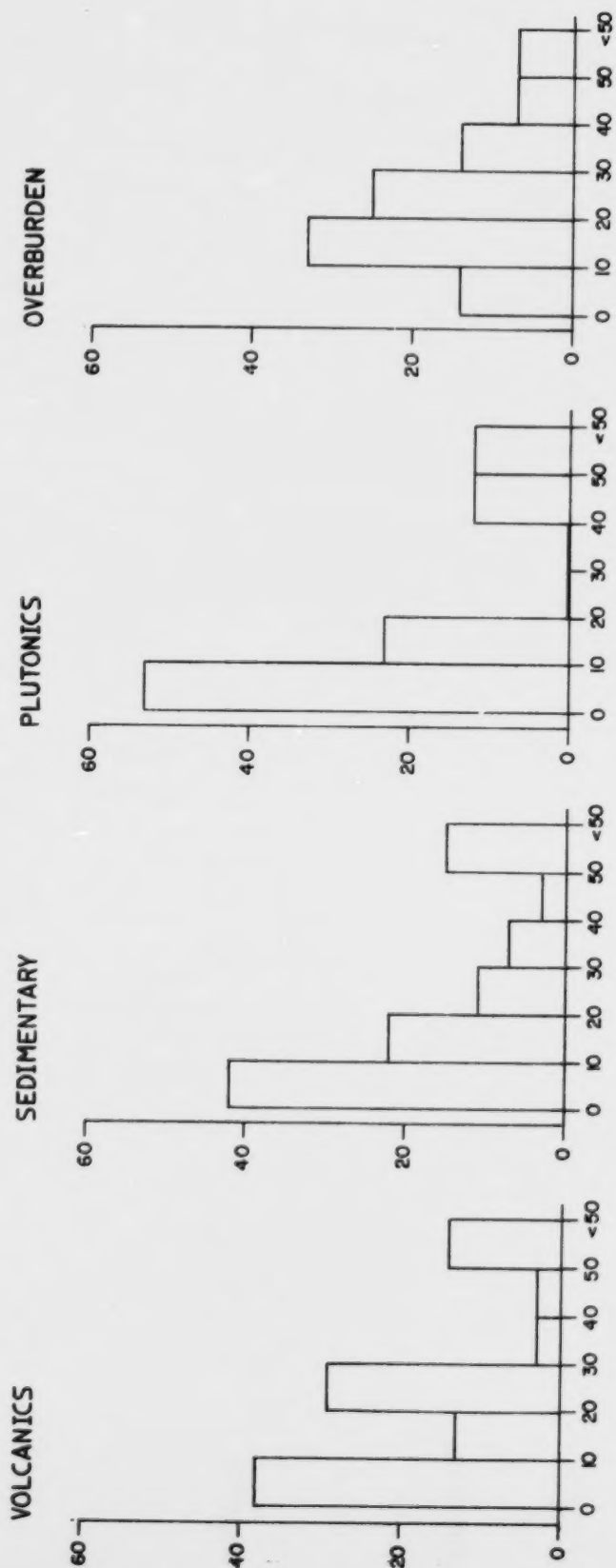
Table 5.3 provides a summary of the major hydrogeologic units defined in the Notre Dame Bay study area.

Figure 5.1 illustrates the percentage distribution of the reported well yields for the hydrogeologic units in 10 l/min increments.

TABLE 5.3

SUMMARY OF HYDROGEOLOGIC UNITS

	<u>Wells</u>	<u>Mean Yield (l/min)</u>	<u>Median Yield(l/min)</u>	<u>Mean Well Depth (m)</u>	<u>Percentage Dry Wells</u>	<u>Percentage 50 l/min or Greater</u>
VOLCANICS	135	28.8	18.0	45.7	34	7
SEDIMENTARY	165	24.8	13.5	43.0	36	10
PLUTONICS	25	20.3	9.0	42.1	35	8
OVERBURDEN	24	24.3	22.5	14.0	37	5



VERTICAL : PERCENTAGE OF WELLS IN EACH 10 L/min. INTERVAL
 HORIZONTAL : WELL YIELD IN LITRES PER MINUTE

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Yield Distribution of Producing Wells

HYDROLOGY CONSULTANTS LIMITED
 CONSULTING ENGINEERS AND GEOLOGISTS

Job No. 8813	Scale AS SHOWN
Drawn by	Date March, 1980
Appr. by	
Reviewed	

Figure 5.1

The well-yield distributions for the defined bedrock units are similar with most producing wells having a yield less than 10 l/min and few wells yielding 30 to 50 l/min. The reported percentages of dry wells and of well yielding 50 l/min or more, are also similar, being about 35 percent and 10 percent, respectively.

The overburden unit exhibits the highest average yield of 22 l/min (5 gpm), with wells generally being completed at a depth of about 15 m (45 ft), or about one-third the depth of the bedrock wells. The yield-distribution graph illustrates that most overburden wells supply about 10 to 30 l/min (2 to 6 gpm) and that fewer overburden wells are in the large-yield range than the bedrock wells.

In summary, the groundwater yield of the overburden and bedrock aquifers is defined as low to moderate, ranging from about 10 to 20 l/min (2 to 5 gpm), but is generally sufficient to meet domestic-water requirements. Larger withdrawals would not be anticipated for the wells with low to moderate yields, recognizing that full drawdowns were likely effected during the testing phase by bailer or air-compressor.

A large percentage of the overburden and bedrock wells, exceeding one-third of the total, yield negligible water or no water, and further, less than 10 percent of the wells reportedly yield 50 l/min or greater, confirming the sporadic, irregular distribution of the defined aquifer units.

Comparison of the reported well depths and yields indicate that the water-producing zones generally occur at shallow depth, less than 30 m (100 ft). Considering this factor together with the apparent aquifer distribution, the potential for developing sustained large withdrawals would not appear promising, particularly from the bedrock units. The largest potential occurs within the stratified overburden adjacent to the river systems, where river infiltration may be feasible.

5.4 Groundwater Movement and Recharge

5.4.1 Movement

Groundwater movement is dependent on the hydraulic head within the water-transmitting formation, with flow occurring in a direction from high fluid potential to low fluid potential. The fluid potential may be simply defined by the following equation:

$$\Phi = gh$$

where Φ = fluid potential (force potential)

g = acceleration (gravity)

h = hydraulic head (elevation head + pressure head)

Local topographic relief has a strong influence on the hydraulic head, with the result that groundwater movement essentially occurs from topographically high areas (uplands) towards topographically low areas (valleys). Groundwater studies have indicated that the water-table configuration is generally a subdued expression of the surface topography, and that the topographic trends may be used to interpret the local groundwater movement in the shallow aquifer systems, with movement occurring in a direction perpendicular to the topographic contours. Within large river basins, deep flow systems may also be developed if the water-transmitting formations extend to considerable depth, with the result that groundwater may bypass a sub-basin in which the recharge occurred to discharge at a lower elevation in a major basin. Deep flow is considered negligible in the study area, as the well-yield interpretation indicated that the main bedrock flow systems occur at relatively shallow depths.

The hydraulic gradient within a recharge area has a downward vertical component, whereas, within a discharge area, there is an upward vertical component. The gradient may be readily determined by the installation of piezometers at various depths in the saturated zone. Although piezometer installations are not present in the study area, it may be deduced from other basin studies that the recharge area is significantly larger than the discharge area in areal dimension.

Groundwater movement may be interpreted to be vertically downward and horizontal throughout much of the study

area, with the flow essentially confined to shallow systems by the relative impermeability of the deep bedrock thereby encouraging the discharge of groundwater to local water courses rather than a regional groundwater system.

5.4.2 Recharge

The annual recharge to the groundwater systems may be estimated from the annual discharge of groundwater to the surface streams, assuming no change in the groundwater storage. Conventional methods available to determine the groundwater component include separation of stream hydrographs and statistical analysis of streamflow data, and have both been applied in the study area.

Streamflow hydrographs were prepared for the daily discharges in 1975 and 1977 at Indian Brook, being an unregulated stream and occurring within a physiographic region similar to the study area. The baseflow, or groundwater contribution, was conservatively estimated by joining the low points on the hydrographs plotted on Figure 5.2, and was determined to comprise about 43 percent of the total flow, or about 335 mm in 1975 and to comprise about 37 percent of the total flow, or about 410 mm in 1977, when the precipitation was somewhat larger than in 1975, at the nearest climatic station at Springdale. As the deduced groundwater recharge was very large, hydrographs were also prepared, as shown on Figure 5.3, for the two major rivers in the study area, the Gander and the Exploits rivers to support the baseflow determination. Hydrograph separations conducted in a similar manner indicated that the apparent groundwater recharge comprised a larger

INDIAN BROOK DIVERSION TO BIRCHY LAKE

DAILY DISCHARGE IN CUBIC METRES PER SECOND

DISCHARGE FLOW 1975, 1977
BASE FLOW 1975, 1977

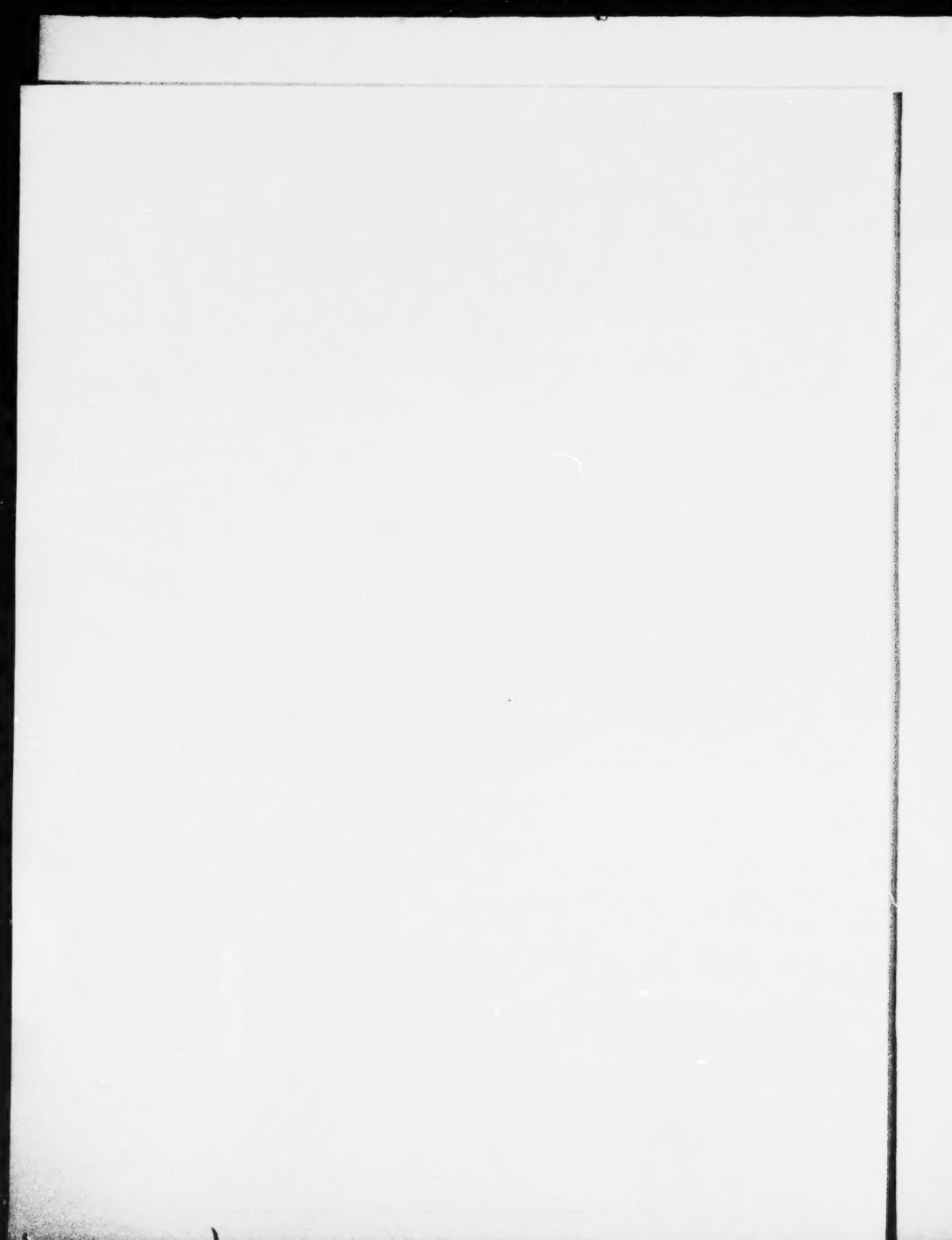


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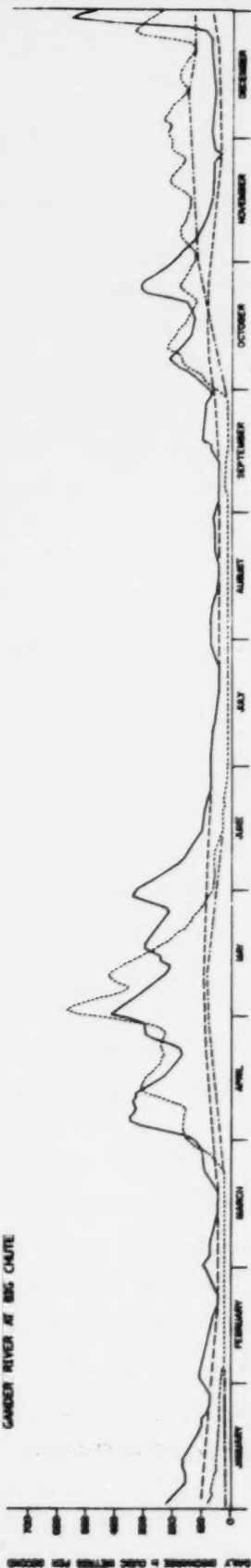
INDIAN BROOK DIVERSION TO
BIRCHY LAKE DAILY DISCHARGE

HYDROLOGY CONSULTANTS LIMITED

Project No.	100/10	Scale	1:1
Date	10/1/75	Author	W.D.
Drawn by	W.D.	Checked by	W.D.
Approved by	W.D.	Project No.	100/10



GANDER RIVER AT BIG CHUTE



EXPLOITS RIVER AT GRAND FALLS



10% PROB. FLOOD
OBS. FLOOD
1% PROB. FLOOD

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
HYDROLOGIC STUDY OF THE NOTRE DAME AREA

GANDER AND EXPLOITS RIVERS DAILY DISCHARGE

HYDROLOGY CONSULTANTS LIMITED			
NAME	PROJECT	DATE	BY
NO. 1	NO. 2	NO. 3	NO. 4
NO. 5	NO. 6	NO. 7	NO. 8
NO. 9	NO. 10	NO. 11	NO. 12
NO. 13	NO. 14	NO. 15	NO. 16
NO. 17	NO. 18	NO. 19	NO. 20
NO. 21	NO. 22	NO. 23	NO. 24
NO. 25	NO. 26	NO. 27	NO. 28
NO. 29	NO. 30	NO. 31	NO. 32
NO. 33	NO. 34	NO. 35	NO. 36
NO. 37	NO. 38	NO. 39	NO. 40
NO. 41	NO. 42	NO. 43	NO. 44
NO. 45	NO. 46	NO. 47	NO. 48
NO. 49	NO. 50	NO. 51	NO. 52
NO. 53	NO. 54	NO. 55	NO. 56
NO. 57	NO. 58	NO. 59	NO. 60
NO. 61	NO. 62	NO. 63	NO. 64
NO. 65	NO. 66	NO. 67	NO. 68
NO. 69	NO. 70	NO. 71	NO. 72
NO. 73	NO. 74	NO. 75	NO. 76
NO. 77	NO. 78	NO. 79	NO. 80
NO. 81	NO. 82	NO. 83	NO. 84
NO. 85	NO. 86	NO. 87	NO. 88
NO. 89	NO. 90	NO. 91	NO. 92
NO. 93	NO. 94	NO. 95	NO. 96
NO. 97	NO. 98	NO. 99	NO. 100

percentage of the local flow, being about 48 percent and 52 percent for the regulated Exploits River and 51 percent and 53 percent for the unregulated Gander River, in 1975 and 1977 respectively. Considering the apparent groundwater storage potential of the overburden and bedrock aquifers, the calculated baseflow is exceedingly large, suggesting that the sustained low flow is largely attributable to the storage and gradual release of surface water from the large areas of bogs, swamps and lakes present within the drainage basins. This interpretation is supported by the peak spring flows, which are significantly smaller than anticipated, due to the basin surface-storage capability.

The groundwater discharge, was also estimated from the hydrometric data by a method, applied by Meyboom, whereby the minimum monthly runoff is considered indicative of the baseflow, and the annual baseflow is the mean monthly minimum flow for the year. Calculations were made for the Indian Brook - Indian Falls hydrometric data, and the groundwater contribution was determined to be 260 mm and 290 mm for 1975 and 1977, respectively.

A third baseflow determination method was considered, which was developed by Wyrick and Lloyd and is based on flow-duration information. The flow exceeded 90 percent of the time has been used to represent the baseflow in a region having a large surface storage potential, similar to the study area; however, the evaluation could not be completed due to the lack of discharge information. Available low-flow information is essentially limited to the information in the

Shawinigan-MacLaren report indicating that the minimum runoff for the study area with a probability of one in twenty years is 95 cu m/day/sq.km, equivalent to about 34 mm of precipitation per year. Although, this minimum flow cannot be directly related to the flow duration, the 1:20 year minimum flow is generally less than the 90 percent exceeded flow, suggesting that minimum flow, or groundwater recharge, may be about 50 mm.

Baseflow calculations have been undertaken by the Geological Survey of Canada by assuming that the lowest streamflow occurring in January, February and March, approximates the groundwater discharge, as during this period, there is negligible surface runoff and evapotranspiration. Within the Notre Dame Bay area, the minimum water stream discharge was determined to be about 200 mm per year. However, the deduced baseflow may be too high, as delayed discharge may be occurring from the bogs and lakes.

The available evaluation methods are inadequate for the local conditions. In conjunction with studies of the flow-duration and precipitation-runoff trends, an observation-well network should be established to determine the inter-relationships between the groundwater stage and stream discharge, and, more importantly, between the stage and groundwater storage, by continuous monitoring of the water-level response. Strategically located near the surface pondings, observation-well nests would also determine whether the bog and swamp reservoirs recharge the aquifers or directly discharge to the surface streams.

6.0 WATER USE

The water sources of the incorporated municipalities in the study area are listed in Table 6.1. The large number of surface-water systems supplying small communities, suggests that the local aquifers have limited yield capabilities. Only three of the municipalities are presently supplied by wells, although, in past years, several of the listed communities were dependent on groundwater, as typified by the Botwood situation.

Communal groundwater systems, may be feasible at other unincorporated municipalities, particularly where a well may have an individual yield exceeding 50 l/min. Table 6.2 lists the communities in which testing has reportedly been undertaken by the municipalities or provincial agencies, together with the reported results. At the communities where negligible water supplies have been intercepted, by the test wells, it is anticipated that local residents are supplied by individual domestic drilled or dug wells.

7.0 QUALITY

The available chemical quality information is listed in Table 7.1. The water samples were reportedly obtained from drilled water supply wells of unknown depths. The well locations, shown on Figure 7.1, suggest that the groundwater samples were obtained from the sedimentary hydrogeologic unit, with the exception of the Moreton's Harbour sample, which likely represents the volcanic hydrogeologic unit.

TABLE 6.1

MUNICIPAL WATER SUPPLY

<u>Municipality</u>	<u>Population Served</u>	<u>Source</u>
Twillingate	1300	Surface
Comfort Cove - Newstead	120	Surface
Lewisporte	4800	Surface
Norris Arm	1275	Surface
Bishop's Falls	--	Surface
Botwood	6000	Surface
Peterview	1100	Surface
Northern Arm	300	Surface
Point Leamington	475	Surface
Triton - Jim's Cove	1050	Surface
Robert's Arm	1200	Surface
Springdale	3300	Surface
King's Point	750	Surface
Middle Arm	350	Surface
Burlington	400	Surface
Little Bay	180	Groundwater
Wild Bight - Beachside	350	Groundwater
Point of Bay	220	Groundwater

TABLE 6.2

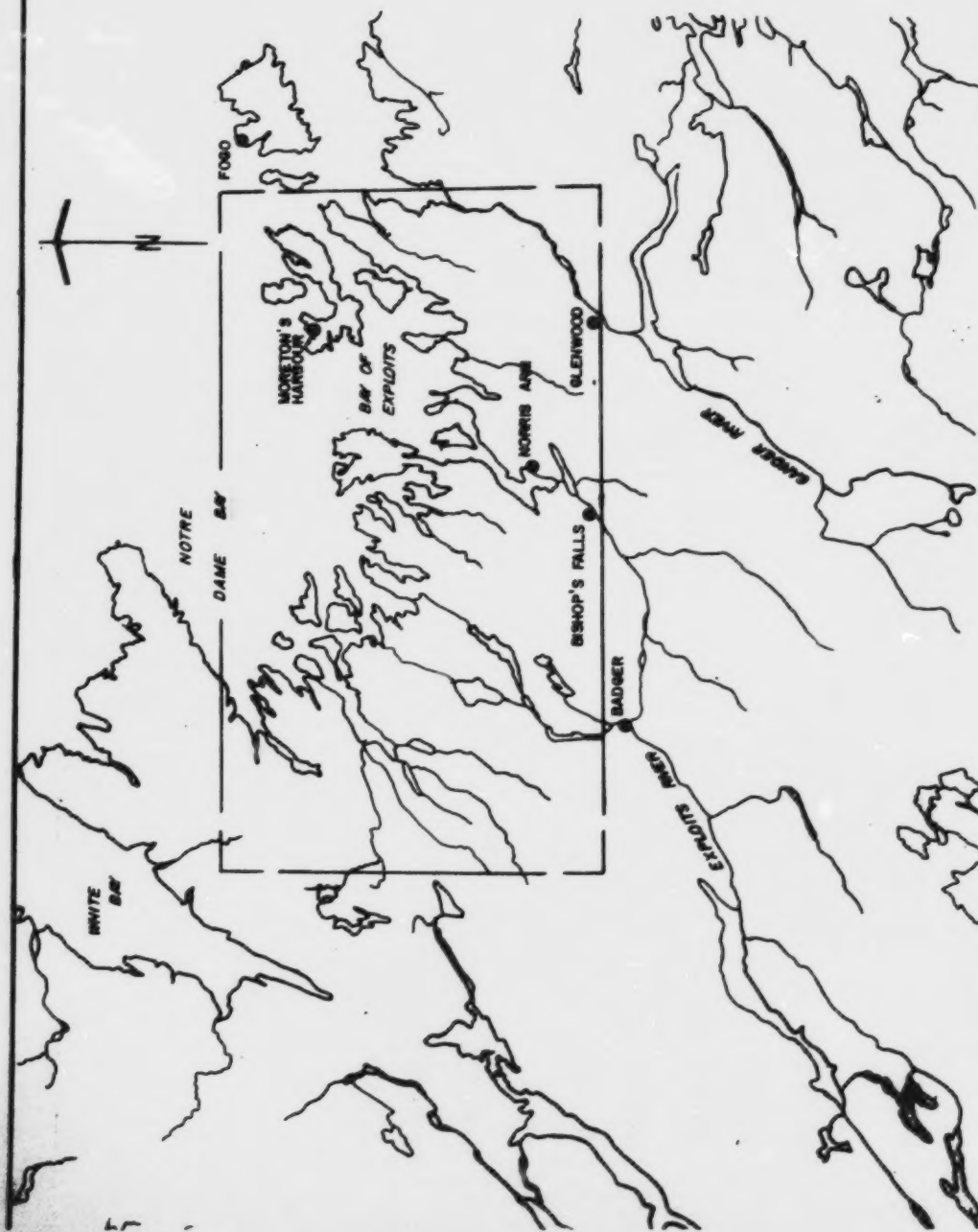
SMALL COMMUNITIES WITH MUNICIPAL TEST WELLS

<u>Municipality</u>	<u>Drilled Wells</u>	<u>Combined Yield(l/min)</u>	<u>Number of Wells With 50 l/min or Greater Yield</u>
Cobb's Arm	3	54	Nil
Pike's Arm	5	Nil	Nil
Port Albert	3	Nil	Nil
Boyd's Cove	4	157	1
Lawrencetown	4	202	1
Port Anson	5	54	Nil
Lush Bight	2	77	Nil
Brighton	11	158	1
St. Patrick	1	90	1
Beaumont	1	68	1
Little Bay Island	8	112	Nil
Harry's Harbour	7	270	2
Jacksons's Cove	5	45	Nil
Durrell	3	18	Nil
Moreton's Harbour	3	Nil	Nil
Tizzard's Harbour	2	5	Nil
Whales Gulch	6	9	Nil
Leading Ticks	18	428	2

TABLE 7.1

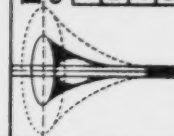
GROUNDWATER CHEMICAL QUALITY (epm)

<u>Location</u>	<u>Calcium</u>	<u>Magnesium</u>	<u>Sodium + Potassium</u>	<u>Bicarbonate + Carbonate</u>	<u>Sulphate</u>	<u>Chloride + Nitrate</u>
BADGER	0.68	0.27	0.34	0.74	0.27	0.28
BISHOP'S FALLS	0.40	0.16	0.29	0.52	0.14	0.16
NORRIS ARM	0.20	0.17	0.40	0.28	0.17	0.32
NORRIS ARM	3.02	1.42	1.80	4.60	0.21	1.43
GLENWOOD	1.25	0.42	1.47	2.50	0.35	0.29
FOGO	1.76	1.44	1.46	2.26	0.48	1.88
MORETON'S HARBOUR	2.01	0.29	1.70	--	--	1.41
MORETON'S HARBOUR	0.69	0.28	0.72	--	--	0.98



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HYDROGEOLOGIC STUDY OF THE NOTRE DAME AREA

Locations of Groundwater Chemical Analyses



HYDROLOGY CONSULTANTS LIMITED
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Figure 7.1

The chemical analyses of these samples are essentially similar, with the groundwater having a low hardness and being in the bicarbonate classification. Slightly elevated chloride concentrations are present in water from wells adjacent to the bay, but may not be evidence of the salt-water intrusion. The chloride variation may be attributable to the bedrock composition, or the location of the well within the groundwater flow system, although deep flow is not apparent from available well data.

Detailed sampling at Moreton's Harbour and at other provincial locations in similar hydrogeologic settings indicate that the groundwater may have taste and staining characteristics due to high iron and manganese. The concentrations of these constituents vary widely, and likely relate to the local bedrock composition in the vicinity of the well bore.

8.0 POLLUTION SOURCES AND SUSCEPTIBILITY

8.1 Sources

Pollution of groundwater sources may occur through the surface disposal and application of contaminants, such as oil and chemical spills, deicing materials, mine tailing, dump and landfill leachates, and septic-tank effluent; the intrusion of salt-water by overpumping of wells adjacent to the coastal areas; and the direct entrance of surface runoff through improperly constructed wells.

Oil and Chemical Spills:

An accidental chemical or oil spill could have a disastrous impact on an aquifer, as low pollutant concentrations may be sufficient to render an aquifer effectively unpotable thereafter. Handling and storage of hydrocarbons and chemicals must be carefully considered to minimize the possibility of spills. In particular subsurface storage facilities, such as gasoline tanks, should be routinely monitored to permit early detection of leaks.

Leachate:

Soluble materials and organic contaminants produced by the movement of infiltrating precipitation through commercial, industrial or domestic wastes may reach underlying groundwater systems and affect water-supply wells. However, the impact on the environment may be minimized by the careful placement of the disposal sites at locations where useable aquifers are not present or where groundwater moves away from developed or potentially developable aquifers.

Deicing Materials:

Salt and salt/sand mixtures may be leached by precipitation into the local groundwater systems, and may locally affect well supplies by increasing the chloride concentration. The placement of the storage piles and the spreading of these materials should be carefully considered to minimize pollution, particularly in the areas adjacent to the treated roads and highways.

Septic Tank Effluent:

The potential contaminants in septic-tank effluent comprise nitrate and bacteria. The probability of bacterial pollution of the underlying groundwater systems should be negligible in areas where the septic tank tile beds are set within thick overburden or raised beds, exceeding two metres of moderately permeable soils. Bacteria are generally removed from effluent in the upper one to two metres of the soil section. In areas where the overburden is absent or thin, there may be a significant possibility of widespread bacterial pollution of groundwater.

Nitrate occurs in domestic sewage effluent at a concentration of about 40 mg/l, and, within highly developed areas, a nitrate buildup is possible dependent on the sewage generation and the available recharge as groundwater inflow and infiltrating precipitation.

Salt-Water Intrusion:

Within the coastline areas, salt-water contamination of the fresh-water aquifers is possible, and would depend on the local withdrawal, the availability of recharge, and the depth of the water-bearing zones. Where large groundwater pumpage occurs, increasing salinization may be anticipated as the fresh-water level is progressively depressed, enabling the lateral movement of sea water or upwelling of the saltwater-freshwater interface into the fractures supplying the wells. The problem may be resolved by decreasing the withdrawal until the salinity is reduced or by the installation of wells further inland, where the fresh water zone is appreciably thicker. Future problems may be anticipated in communities adjacent to the coastline, as the water demand increases to meet population growth, and may eventually necessitate the installation of inland communal wells.

Well Construction:

Many water-supply wells are drilled in a manner that may allow surface runoff or septic-system effluent to enter the aquifer. To eliminate this potential pollution source, a well-completion technique that provides for the plugging of the annular space to a depth not less than three metres below the ground surface, should be emphasized to the well contractors.

8.2 Susceptibility

Throughout much of the study area, the overburden cover is granular; the aquifers are present at relatively shallow depth; and the direction of groundwater movement is generally downward, indicative of recharge conditions. Consequently, the pollution susceptibility of the study area ranges from moderate to high, dependent on the overburden thickness and population distribution. The areas having the highest pollution potential include Units 1 and 3, shown on the surficial hydrogeological map, Map 2. Significantly, the areas of highest population density and of predominantly thin drift, generally less than three metres, occur within Unit 1. Within Unit 3, granular materials commonly extend to surface, which may provide contaminant access to the aquifers. Surficial Unit 2 is deduced to have a moderate pollution susceptibility, due to the presence of thicker sediments, capable of attenuating most infiltrating contaminants.

9.0 CONCLUSIONS

The defined overburden and bedrock hydrogeologic units are capable of providing low to moderate yields (0 to 50 l/min) of groundwater to individual wells. About one-third of the wells, drilled in the overburden and the bedrock, are

reportedly dry or yielded negligible water. Drilling to locate communal water supplies has largely been unsuccessful, with less than 10 percent of the drilled wells with yields exceeding 50 l/min. No specific area in the overburden or bedrock could be defined in which larger yields may be assured, although the glaciofluvial sediments should have the best potential for the development of municipal wells.

The chemical quality of groundwater is generally acceptable for domestic use, with exception of nuisance constituents, iron and manganese, which locally occur in concentrations causing staining and taste problems. Salt-water intrusion is not evident; however, with increased groundwater demands, salinization could substantially increase in the coast-line communities dependent on well systems.

Available well data are largely limited to depths and yields, precluding detailed evaluation of the hydraulic characteristics, sustained yields and quality of the defined hydrogeologic units. The hydrogeologic assessment may be periodically refined to confirm the local conditions, as information is routinely submitted by the well contractors on the nature of the intercepted overburden and bedrock formations; the depths of water-bearing zones; the water-level trends during pumping and recovery tests; and quality conditions.

Conventional hydrograph analyses provided baseflows, or groundwater discharges, appreciably larger than anticipated for the known hydrogeologic conditions. These high values are attributed to the extensive bogs and swamps, which act as

surface reservoirs and slowly release water to the rivers. Present indications are that groundwater recharge may amount to about 50 mm, and appreciably exceeds the present groundwater withdrawal in the study area.

A regional monitor-well network should be established for determination of the water quality, the groundwater levels, and direction of groundwater movement in each of the defined hydrogeologic units. The network could comprise a selection of existing, unused drilled and dug wells, together with several strategically placed, multiple-well installations. Future monitoring of the groundwater levels and gradients may eventually establish the availability of groundwater recharge to the aquifers.

The pollution susceptibility of the overburden and bedrock aquifers ranges from moderate in the inland areas to high in the coastal areas, on the basis of the overburden thickness and population density. Careful consideration of the placement of waste disposal site, road salt, oil chemical storage facilities will be required to minimize groundwater pollution.

APPENDIX A: WATER WELL RECORDS

TABLE A-1

Water Wells Drilled in Overburden

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
Springdale Junction	558200	Dept. of Forestry	---	10.64	35	45.46	10				10.64	35
	5481300											
Norris Arm	626500 5438500	Burnt Burry Motel	---	10.34	34	54.55	12				10.34	34
		Town Council	--	10.64	35	36.37	8				10.64	35
		Don Whitt	76/9	10.64	35	18.18	4				10.64	35
		--	--	13.07	43	--	--				13.07	43
		--	61/6	10.34	34	--	--				10.34	34
		--	65/11	13.68	45	--	--				13.64	45
		Dept. Min. 61/3 Affair and Supply	75	22.8	75	--	--				22.8	75
		Dept. Min. 61/6 Affair & Supply	51	15.50	51	--	--				15.5	51
		Notre Dame -- Integrated School Board	73	22.19	73	27.28	6				22.19	73
		Mr. W. Harvey	77/6	13.64	45	4.54	1				13.55	45
									2.13			

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
Norris Arm North	--	--	--	10.03	33	--	--		10.03	33		
		W. Harvey	76/6	23.64	45	4.54	1		2.13		13.55	45
Norris Arm South		--	62/8	19.76	65	--	--				19.76	65
Notre Dame Junction	6939100 5442600	Canadian	71/4	15.11	53	18.18	4				16.11	53
		Irving Oil Co. Ltd.	---	12.16	40	36.37	8				12.16	40
		Golden Eagle Canada Ltd.	--	14.9	49	18.87 - 22.73	4 - 5				14.9	49
		Provincial (Notre Dame Park)	--	9.42	31	27.73 - 27.18	5 - 6				9.42	31
		C.N. Rail- way	68/10	14.9	49	11.37	2½				14.9	49
		Golden Eagle Service Station	71/12	9.12	30	22.73	5				9.12	30
		Golden Eagle Canada Ltd.	---	1.82	6	----	----				----	--

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u> Metres Feet	<u>Yield</u> L/m Gpm.	<u>Water</u> Quality	<u>Water</u> Level Metres	<u>Overburden</u> Thickness Metres Feet
Point Leamington	616100 5465500	Town Council	75/5	12.16 40	27.28 6		12.16	40
		Salvation 65/4 Army School		15.2 50	---		15.2	50
		Salvation 65/4 Army School		27.36 90	--		27.36	90
Brown's Arm	633300 5457700	Michael Alyward	77/7	9.12 30	13.64 3		9.12	30
Birchy Bay	664000 5470000	Water Committee	71/10	9.42 31	---		9.42	31

TABLE A-2

Water Wells Drilled in Plutonic Rocks

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water Quality</u>	<u>Water Level</u>		<u>Overburden Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
Durrell (8)	663000 5503000	Eric Clarke	75/7	30.4	100	4.54	1				1.82	6
		G. Young	76/9	31.94	105	4.54	1				2.43	8
		Raymond Waterman	76/7	76	250	2.27	½				1.82	6
		Element- ary School	71/2	53.2	175	13.64	3				6.08	20
		E. Legge	76/9	28.88	95	--	--				2.13	7
		Water Supply Committee	72/2	48.03	158	9.09	2				3.65	12
		Water Supply Committee	72/3	48.03	158	Nil	Nil				1.52	5
		Water Supply Committee	72/2	48.03	158	9.09	2				1.52	5
		George Keefe	75/7	35.57	117	13.64	3				2.43	8
Little Harbour	665200 5499600											

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Middle Arm	565500 5505900	Community Council	68/8	30.4	100	54.55	12	Fresh		1.82	6
Rattling Brook	560500 5497300	Carl Anstey	76/9	19.18	96	90.92	20			3.64	12
Birchy Bay	664000 5470000	Pente- costal School Board	74/10	61.71	203	---	---			1.52	5
		Water Committee	71/10	61.71	203	Nil	Nil			1.52	5
		Water Committee	71/10	61.71	203	45.46	10			0	0
		Water Committee	71/9	60.8	200	Nil	Nil			0	0
Manuel's Cove	663400	Community	--	36.48	120	4.54	1			2.13	7

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
Twilling- gate	661500 5402300	Roy Slade	76/9	47.12	155	3.41	3/4				2.73	9
		Flower Crisp Chicken	76/7	22.8	75	4.54	1				--	--
		Imperial Oil Limited	74/10	41.04	135	18.18	4				2.58	8.5
		Western Const. Ltd.	--	57.15	188	13.64	3				3.34	11
		R.C.M.P. Detachment	68/6	60.8	200	--	--				10.64	35
		Dr. Garcia	69/9	24.32	80	4.54	1		3.04		2.43	8
		Dr. John Olds	69/9	41.65	137	--	--				1.52	5
		Nfld. Light and Power	76/9	15.2	50	45.46	10				3.96	13

TABLE A-3

Water Wells Drilled in Lush Bight Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Cards Harbour	599500	Mathew Henstridge	73/8	11.55	38	13.64	3			0.61	2
	5485000										
		Rey Windsor	73/8	12.16	40	--	--			0	0
Little Bay	575700	-	69.9	18.24	60	4.54	1			5.47	18
	5494500										
Port Anson	584000 5487500	Dept. of	75/8	44.08	145	--	--			6.38	21
		Transport and Commission									
		Community	75/7	52.59	173	9.09	2			1.82	6
		Council									
		D.M.A.H.	75/10	106.4	350	--	--			6.69	22
		Dept of	74/9	29.79	98	2.27	1½			2.13	7
		Transport and Commission									
		D.M.A.H.	75/10	76	250	6.82	1½			5.78	19
		Community	75/8	33.44	110	31.82	7			2.43	8
		Council									
		Community	75/8	46.51	153	9.09	2			1.82	6
		Council									

<u>Community</u>	<u>Location E N</u>	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water Quality</u>	<u>Water Level Metres</u>	<u>Overburden Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
Beachside	579600 5499300	Town Council	69/11	111.87	368	68.19	15			2.13	7
		Town Council	71/6	61.71	203	36.37	8			2.13	7
		Town Council	69/11	43.47	143	54.55	12			--	--
		Dennis Fabry	75/8	36.48	120	9.09	2			5.17	17
		Community Council	71/6	20.67	68	--	--			13.68	45
Brighton	598500 5489000	Community Council	71/6	89.07	293	9.09	2			3.5	11.5
		--	--	57.76	190	31.82	7		10.73	--	--
		D.M.A.H.	75/8	61.71	203	--	--			4.56	15
		D.M.A.H.	75/8	61.71	203	--	--			2.14	7
		D.M.A.H.	75/8	48.03	158	--	--			1.82	6
		Water Supply Committee	73/2	28.27	93	27.28	6			1.82	6

Community Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
		Water Supply Committee	71/11	20.37	67	27.28	6			2.13	7
		Water Supply Committee	73/2	32.83	108	22.73	5			1.82	6
		D.M.A.H.	73/8	69.92	230	4.54	1			1.82	6
		Salvation Army Citadel	75/2	27.06	89	27.28	6			3.65	12
		D.M.A.H.	--	29.79	98	72.74	16	poor	9.79	1.82	6
		D.M.A.H.	75/10	12.16	40	--	--			0.91	3
		D.M.A.H.	75/8	43.47	143	very low				1.82	6
		John Ince	73/5	24.93	82	14.64- 18.18	3-4			1.52	5
		Francis Verge	73/5	19.76	65	9.09- 14.64	2-3			0.61	2
		--	73/6	17.02	56	--	--			1.22	4
		Dept. of Trans. and Comm.	75/1	30.70	101	18.18	4			0.61	2
		Gower Fudge	73/8	9.12	30	--	--			0.91	3
		Water Supply Committee	73/4	31.31	103	31.82	7		4.26	3.04	10

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
		--	--	31.31	103	5.91	1.3		8.91	--	--	--
		Dept. of Highways	73/5	20.06	66	27.28	6		3.04		1.52	5
		Dawson Fudge	73/5	20.06	66	14.64	3				0.3	1
		D.M.A.H.	75/10	34.35	114	--	--				2.43	8
		Cyril Fudge	77/5	36.48	120	1.14	$\frac{1}{2}$		6.08		1.82	6
		Dextor Bridger	77/5	38	125	1.14	$\frac{1}{2}$		6.69		2.43	8
St. Patricks	571900 5491000	D.M.A.H.	74/9	48.03	158	90.92	20				1.82	6
Wild Bight	576200 5717800	Town Council	--	48.03	158						--	--
		Town Council	--	109.44	360						--	--

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet	L/m	Gpm			Metres	Feet
Harry's Harbour	577500 5505700	D.M.A.H.	-----	64.45	212	6.82	1.5		7.30	-----	-----
		D.M.A.H.	-----	85.12	280	11.37	2.5		7.11	-----	-----
		D.M.A.H.	73/3	60.8	200	--	---			1.82	6
		D.M.A.H.	73/3	89.07	293	13.64	3			1.82	6
		D.M.A.H.	73/3	57.15	188	54.56	12			1.82	6
		D.M.A.H.	-----	30.25	99.5	--	---		24.47	-----	-----
		D.M.A.H.	75/9	30.4	100	181.84	40			2.43	8
		D.M.A.H.	75/9	61.71	203	--	---			4.26	14
Jackson's Cove	572400 5503700	D.M.A.H.	75/9	61.71	203	--	---			2.43	8
		D.M.A.H.	75/10	61.71	203	27.28	6			2.43	8
		D.M.A.H.	75/9	66.27	218	18.18	4			2.43	8
		D.M.A.H.	75/9	61.71	203	--	---			2.43	8

TABLE A-4

Water Wells Drilled in Cut Well Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm			Metres	Feet
Beaumont	595500	Community	75/12	76	250	Nil	Nil			1.82	6
	5496500										
Beaumont North	594700	Community	75/12	70.83	233	Nil	Nil			4.86	16
	5497000										
Beaumont South	594300 549500	Community	75/11	76	250	9.09	2			3.04	10
		Community	75/12	76	250	Nil	Nil			2.43	8
		Community	75/12	54.72	180	68.19	15			5.17	17
		Community Council	71/2	34.95	115	13.64	3			2.13	7
Little Bay Island	587300 5499400	Community Council	76/1	34.95	115	22.73- 27.28	5-6			2.43	8
		Community Council	71/2	37.09	122	13.64	3			0.91	3
		Community Council	--	37.39	123	12.64	3			1.82	6
		Community Council	76/1	66.88	220	9.09	2			1.82	6

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
		Dept. of Fisheries	76/2	66.88	220	68.19	15			6.08	20
		Dept. of Fisheries	75/5	75.39	248	9.09	2			4.86	16
		Dept. of Fisheries	75/6	75.39	248	22.73	5			3.34	11
		Community Council	76/1	94.24	310	9.09	2			2.43	8
		Community Council	76/1	69.92	230	9.09	1-2			2.13	7
		Dept. of Fisheries	75/5	85.12	280	68.19	15			1.82	6
		Dept. of Fisheries	75/5	93.63	308	--	--			4.56	15
		Dept. of Fisheries	75/6	92.72	305	--	--			3.34	11
		Green Bay Integrated School Board	--	51.68	170	272.76-318.22	60-70			3.34	11
		Community Council	70/11	26.45	87	27.28	6			2.13	7
		Roland Weir	--	21.28	70	3.41	3/4			2.73	9
		Dept. of Fisheries	--	42.56	140	27.28	6			2.43	8
		Dept. of Fisheries	--	57.46	189	36.37	8		15.75	--	--

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> <u>Metres</u>	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
Lush Bight	592700	Community	75/11	61.71	203	45.46	10			3.04	10
	5944000		71/11	16.11	53	31.82	7			4.86	16

TABLE A-5

Water Wells Drilled in Robert's Arm Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Pilleys Island	592200 5484300	Pro Des Co.	75/8	93.63	308	14.64	3			4.26	14
		Community Council	--	69.92	230	Nil	Nil			2.74	9
		D.M.A.H.	75/6	75.39	248	--	--			--	--
		School	--	92.11	303	22.73	5			4.26	14
		Terra Nova Contracting Limited	75/5	28.27	93	4.54 - 9.09	1-2			4.26	14
		Water Supply Committee	71/12	34.35	113	27.28	6			2.13	7
		Community Council	75/6	76	250	Nil	Nil			1.82	6

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> <u>Metres</u>	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
		Community Council	--	76	250	Nil	Nil			2.13	7
		Water Supply	72/1	18.24	60	22.73	5			1.52	5
		Water Supply Committee	72/3	18.24	60	27.28	6			2.43	8
		Community Council	74/1	22.8	75	4.54	1			2.74	9
		Community Council	74/1	22.8	75	6.82	1.5			4.56	15
		Water Supply Committee	72/2	22.8	75	27.28	6			3.65	12
		D.M.A.H.	72/3	22.8	75	27.28	6			2.79	9
		D.M.A.H.	74/1	22.8	75	6.82	1½			4.56	15
		Water Supply Committee	72/2	22.8	75	27.28	6			0.91	3
		Water Supply Committee	72/2	21.28	70	27.28	6			3.65	12
		Mr. James	73/	45.6	150	Nil	Nil			5.17	17
		Community Council	--	38.91	128	4.54	1			5.78	19
		Community Council	--	43.47	143	27.28	6			2.13	7
		D.M.A.H.	75/10	25.23	83	Nil	Nil			--	--

TABLE A-6

Water Wells Drilled in Exploits Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Loon Bay	656500 5459400	Ray Dian	69/8	15.2	50	---	---	---	---	---	---
		United Church Camp	69.7	37.08	122	22.73	5			14.59	48
		U.C. Church	65/6	25.84	85	---	---			13.68	45
		Comm.	69/7	31.31	103	27.28	6			16.72	55
		Notre Dame Integrated School Board	74/10	33.44	110	36.37	8			9.73	32
Paradise	659500 5266200	Ivan Harris	77/6	51.68	170	22.73	5			3.65	12
		Shirley Clarke	77/8	47.12	155	9.09	2			4.26	14
		Sobey Penney	76/10	48.64	160	9.09	2			5.17	17
		Peter Burridge	75/10	31.01	102	11.37	2½			6.69	22
		Phillip Sharpe	76/10	9.73	32	90.92	20			4.26	14

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm			Metres	Feet
		Howard Gossee	77/2	30.4	100	15.91	3½			20.06	12
		Desroy Develop	---	45.6	150	6.82	1½			20.06	66
		Desroy Develop	---	20.06	66	27.28	6			20.06	66
		Desroy Develop	---	39.52	130	----	--			4.26	14
		Desroy Develop	70/6	21.35	70	----	--			---	--
		Mrs. Pretty	74/7	30.4	100	----	--			6.69	22
		Aubrey Gosse	74/8	30.4	100	----	--			6.69	22
		Robert Maidment	75/4	31.92	105	2.27	½			3.35	11
		Soan Gechan & Kevin Hearn	77/4	54.72	180	--	--			1.82	6
		Mike Quilty	74/9	27.97	92	--	--			8.21	27
		Kevin Hearn	76/6	21.28	70	22.73	5			3.34	11

TABLE A-7

Water Wells Drilled in Moreton's Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm			Metres	Feet
Whales Gulch	651900 5492900	Water Supply Committee	71/11	16.11	53	Nil	Nil			1.52	5
		Water Supply Committee	71/11	48.03	158	4.54	1			1.52	5
		Water Supply Committee	71/11	20.67	68	Nil	Nil			1.52	5
		Water Supply Committee	71/11	29.79	98	--	--			4.56	15
Moreton's Harbour	654400 5492700	-----	71/11	61.71	203	Nil	Nil			4.86	16
		Water Supply Committee	71/11	47.12	155	4.54	1			1.52	5
		Community	71/11	60.8	200	Nil	Nil			4.56	15
		Community	71/11	60.8	200	Nil	Nil			1.22	4
Tizzard's Harbour	658700 5495500	School Board	70/9	29.79	98	159.11	35			2.74	9
		Community	--	60.8	200	small	small		12.16	--	--
		Morley Lock	76/9	21.28	70	2.27	$\frac{1}{2}$			1.82	6
		D.M.A.H.	71/11	26.75	88	2.27	$\frac{1}{2}$			--	--

TABLE A-8

Water Wells Drilled in Botwood Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level		Overburden Thickness	
				Metres	Feet	L/m	Gpm.		Metres	Feet	Metres	Feet
Lawrence- town	625600 5450300	Well Comm. 71/9 of Lawrencetown		57.15	188	9.09	2				7.6	25
		Well Comm. -- of Lawrencetown		45.6	150	3.41	0.75				5.47	18
		D.M.A.H. --		38	125	45.46	10				9.12	30
		D.M.A.H. --		13.07	43	136.38	30				--	--
		Charles Butler	77/7	44.69	147	2.27	$\frac{1}{2}$				0.61	2

TABLE A-9

Water Wells Drilled in Wild Right Group

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
Northern Arm	618700 5448300	Botwood Town Council	69/4	42.27	139	68.19	15			10.03	33
		Botwood Town Council	69/4	46.82	154	90.92	20			9.12	30
		Salvation Army	62/6	19.15	63	--	--			17.63	58

TABLE A-10

Water Wells Drilled in Sansom Formation

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Cobbs Arm	675200 5498600	Water Supply Committee	72/2	48.03	158		6			1.52	5
		Water Supply Committee	72/2	34.35	113		5			2.13	7
		Water Supply -- Committee	--	---	---		3			---	--
		Rob Saunders	76/6	42.56	140		$\frac{1}{2}$			2.43	8
Leading Ticks	612000 5483700	Curtis Ledrew	76/6	56.24	185		$\frac{1}{8}$			3.34	11
		----	72/1	36.48	120		--			1.22	4
		Water Supply -- Committee	--	26.84	85		$1\frac{1}{2}$ -2			1.52	5
		Community Council	---	34.35	113		2			1.82	6
		Community Council	71/7	34.35	113		3			2.13	7
		Community Council	72/3	16.11	53		8			2.13	7

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
		Community Council	72/3	16.11	53		2				1.82	6
		Community Council	71/5	84.81	279		1				2.74	9
		Community Council	---	28.88	95		2-3				1.52	5
		Community Council	74/2	57.12	188		3				5.17	17
		Eastern Technical Service	---	91.2	300						---	---
		Community Council	74/3	102.75	338						---	---
		Community Council	71/5	36.48	120		15				1.82	6
		Community Council	65/7	11.25	37		--				6.69	22
		Community Council	72/3	54.72	180		6				3.65	12
		Community Council	72/3	27.36	90		6				5.78	19
		Dept. of Trans. & Comm.	75/1	31.92	105		4-5				3.34	11

Community	Location E N	Owner	Date	Depth		Yield L/m	Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet				Metres	Feet
Virgin Arm	661000 5488000	Comm. of Leading Tickles West	75/1	57.76	190	2			2.13	7
		Comm. of Leading Tickles West	75/1	25.23	83	8-9			2.13	7
		Comm. of Leading Tickles West	75/1	45.6	150	2			2.13	7
		Comm. of Leading Tickles West	75/1	39.52	130	30		1.22	2.13	7
		Comm. of Leading Tickles West	---	28.88	95	--			3.04	10
		Ewen Farr	76/9	39.82	131	2.27	½		3.04	10
		M.D.B. Integrated School Board	70/9	89.07	293	Nil	Nil		3.5	11.5
		M.D.B. Integrated School Board	70/9	30.4	100	Nil	Nil		3.04	10
		M.D.B. Integrated School Board	72/1	93.63	308	Nil	Nil		3.65	12

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Carters Cove	659500 5489200	Post Office	76/10	60.8	200		1/2			3.95	13
				34.96	115		1			1.82	6
Pike's Arm	674400 5501800	D.M.A.H.	73/10	34.35	113		--			2.13	7
				34.35	113		--			3.04	10
				34.35	113		--	Salt		---	--
				20.67	68		1/2			4.27	14
				27.36	90		--			3.04	10

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>L/m</u>	<u>Yield</u> Gpm.	<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet					Metres	Feet
Port Albert	678500 5490500	D.M.A.H.	72/1	45.6	150	---	---	---	---	---	---
		D.M.A.H.	72/1	45.6	150	---	---	---	---	1.82	6
		D.M.A.H.	72/1	45.6	150	---	---	---	---	1.82	6
Campbellton	651000 5461000	D.M.A.H.	71/9	38.91	128	136.38	30	---	---	0	0
		D.M.A.H.	---	59.28	195	Nil	Nil	---	---	0	0
		D.M.A.H.	71/9	60.8	200	Nil	Nil	---	---	---	---
		D.M.A.H.	71/9	43.47	143	13.64	3	---	---	0	0
		D.M.A.H.	---	35.87	118	49.10	10.8	Clear, 0.3 good taste no odor.	---	---	---
		D.M.A.H.	---	31.31	103	4.54	1	---	2.16	---	---
Pente- costal School	70/3	D.M.A.H.	---	29.12	98.5	17.27	3.8	slight odor	5.62	---	---
		Pente- costal School	70/3	25.23	83	227.3	50	---	---	---	---

Community _____
 Location
 E _____
 N _____

Owner	Date	Depth Metres	Depth Feet	L/m	Yield Gpm	Water Quality	Water Level Metres	Overburden Thickness Metres	Overburden Thickness Feet
D.M.A.H.	---	25.14	82.7	50	11	cloudy & odorous	4.86	-----	-----
D.M.A.H.	71/8	34.96	115	36.37	8	clear water	--	3.04	10
R.J. Noah & Assoc. Ltd.	75/5	91.2	300	4.54	1	----		-----	--
D.M.A.H.	---	39.22	129	59.10	13	----	6.69	-----	--
Govern- ment	68.7	30.4	100	34.1 - 36.37	7½-8			2.13	7
Salvation Army School	67/11	33.44	110	--	--			2.74	9
Adam Milley	77/7	34.96	115	2.27	½			3.04	10
Austin Rideout	77/7	34.66	114	2.27	½		3.04	2.74	9
George Hawkins	77/7	34.05	112	11.37	2½		1.82	2.13	7
Ambrose Wall	77/7	35.87	118	0.57	1/8		34.35	0.91	3
George Young	77/7	10.94	36	0.57	1/8			0	0
Danny Organ	77/7	27.97	92	4.54	1			2.13	7

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u>		<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
Cottles Island	654400 5486200	Edgar Collhan	77/5	25.84	85	18.18	4				0	0
		Otto Wheeler	77/7	14.90	49	2.27	½				1.22	4
		Salvation Army School	68/9	37.09	122	54.55	12		1.52		0	0
		Water Supply Committee	71/10	---	---	Nil	Nil				1.52	5
		Water Supply Committee	----	---	---	4.54	1				1.82	6
		Water Supply Committee	---	75.39	248	Nil	Nil				1.52	5
		Water Supply Committee	71/10	52.59	173	---	---				1.52	5
		Water Supply Committee	71/10	84.51	278	4.54	1				1.82	6

TABLE A-11

Water Wells Drilled in New Bay Formation - Exploits Group

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Meters	Feet	L/m	Gpm.			Metres	Feet
Phillip's Head	623300	D.M.A.H.	73/3	79.95	263	9.09	2			2.74	9
	5453700										
Stanhope	638800	Fred Day	77/7	20.67	68	18.18	4			0.91	3
	5459900										
Brown's Arm	633300 5457700	D.M.A.H.	71/9	29.79	98	22.73	5			15.81	52
			--	61.71	203	22.73	5			2.43	8

TABLE A-12

Water Wells Drilled in Port Leamington Formation

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Point Leamington	616100 5465500	Town Council	--	43.47	143	13.64	3			3.65	12
		Town Council	--	57.15	188	---	---			7.45	24.5
		Town Council	--	48.03	158	6.82	1.5			7.45	24.5
		Town Council	--	216.75	713	---	---			3.65	12
		S.A. High School	-- 70/7	112.48 107.31	370 353	27.28 ---	6 ---			39.82 3.65	131 12
		Salvation Army School	68/1	91.2	300	45.46	10			6.69	22
		S.A. School	68/10	88.16	290	---	---			6.08	20
		"	65/4	30.4	100	---	---			4.56	15

TABLE A-13

Water Wells Drilled in Wig Wam Formation of Bot Wood Group

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Botwood	621000 5445000	Golden Eagle Service Station	70/10	16.11	53	136.38	30			--	--
		Frank Dalley	77/7	17.33	47	13.64	3		1.82	3.65	12
		D.M.A.H.	74/1	34.35	113	6.82	1½			12.16	40
Bishop Falls	611000 5430000	Canadian Legion	--	38	125	--	--			13.64	45
		Roman Catholic	62/10	30.70	101	--	--			8.51	28
		Blackwood's Hotel	-	50.16	165	--	--			--	--
Norris Arm Junction		Fred Day	77/7	20.67	68	18.18	4		2.74	0.91	3
		Irving Oil Co. Limited	-	12.46	41	--	--			1.22	4
Norris Arm North		--	--	18.24	60	--	--			--	--
		--	--	18.24	60	--	--			--	--
		--	62/6	42.56	140	--	--			21.3	70

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u> Metres Feet	<u>Yield</u> L/m Gpm	<u>Water</u> Quality	<u>Water</u> Level Metres	<u>Overburden</u> Thickness Metres Feet
		--	--	26.45 87	--	--	--	10.94 36
		--	--	19.46 64	--	--	--	15.2 50
		Alfred Menchinton	76/9	18.85 62	4.54 1	--	--	16.42 54
Norris Arm South		Winston Hollelt	71/9	18.85 62	136.38 30	--	--	12.98 46
		--	66/7	36.48 120	--	--	--	--
		--	66/8	40.13 132	--	--	--	19.15 63
		--	66/3	51.07 168	--	--	--	4.86 16
		--	64/3	44.08 145	--	--	--	5.78 19
Lewis- porte	641100 5456000	Dept. Mines Agriculture and Resources (Forest Ranger Station)	70/1	61.71 203	67.19 15-20	--	--	3.04 10
		British American Oil Co. Limited	66/ 66/	33.74 111	15.91 3½	--	3.34	15.2 50
Norris Arm	626500 5438500	--	65/1	18.85 62	--	--	--	14.29 47
		--	65/2	40.43 133	--	--	--	14.29 47
		--	66/1	37.09 122	--	--	--	28.89 95

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water Quality</u>	<u>Water Level</u>		<u>Overburden Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>		<u>Metres</u>	<u>Feet</u>	<u>Metres</u>	<u>Feet</u>
		John Fry Ltd.	73/9	69.31	288	13.64	3				14.59	48
		--	61/4	33.44	110	--	--		10.64		20.37	67
		Leroy Haynes	--	57.15	188	2.27 - 4.54	1/2-1				9.73	32
		--	63/9	12.16	40	--	--				6.10	20
		Valmond Head	77/5	72.69	240	2.27	1/2		4.56		15.5	51
		Rev. Father Coady	67/7	70.83	233	22.73	5				6.69	22
		Rev. Father Coady	65/10	45.6	150	13.64	3				17.33	57
		Ganzo Gillingham	76/9	82.08	270	2.27	1/2				9.42	31

Community	Location E N	Owner	Date	Depth		Yield		Water Quality	Water Level Metres	Overburden Thickness	
				Metres	Feet	L/m	Gpm.			Metres	Feet
Boyd's Cove	669700 5479600	Water Supply Committee	71/10	53.2	175	136.78	30	No water colour		1.82	6
		Water Supply Committee	71/10	60.8	200	4.54	1	No water colour		0.912	3
		Committee Council	71/10	60.8	200	18.18	4	No water colour		0.912	3
		D.M.A.H.	76/10	60.8	200	--	--			1.82	6
		Ronald Newman	76/10	2.04	60	2.27	$\frac{1}{2}$			1.22	4
		--	64/4	42.56	140	--	--			3.04	10
		Mr. H. Freake	77/7	40.13	132	2.27	$\frac{1}{2}$		30.4	2.13	7
		Patrick Newman	77/7	33.74	111	2.27	$\frac{1}{2}$		1.23	1.82	6
		Herbert Simms	77/7	20.67	68	13.64	3			2.43	8
		Canadian Javelin Limited	--	6.99	23	36.37	8			2.13	7

TABLE A-14

Water Wells Drilled in Dunnage Melange Formation

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
New Stead	655100	--	68/6	24.32	80	54.55	12			9.73	32
	5473800										
Little Burnt Bay	639800	Pente-	70/8	34.35	113	68.19	15			1.52	5
	5467500	costal School Comm.									
Comfort Cove	655300 5474500	Community Council	70/1	61.71	203	9.09	2	Tested Bact., Sats., Coliform 2/100 m.		1.52	5
		Govern-	68/8	50.77	167	--	--			1.52	5
		ment									
		Community of Comfort Cove	71/3	25.23	83	18.18	4			3.65	12
		Newstead	71/9	25.23	83	68.19	15			1.52	5
		Guy	69/1	25.23	83	9.09	2			3.19	10.5
		Eveleigh									
		Golden Eagle - Canada Limited		45.6	150	9.09	2			3.95	13

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> Metres	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
Community Council		Community Council	71/5	59.28	195	31.82- 36.37	7-8			3.04	10
		Dept. of Public Works	69/10	66.27	218	18.18	4			9.73	32
		Community Council	71/5	89.07	293	36.37- 45.46	8-10			1.52	5
		--	68/6	24.32	80	--	--			--	--
		Community Council	71/9	57.76	190	--	--			3.04	10
		Community Council	71/3	70.83	233	19.91	3.5			3.95	13
		Harvey Dawe N.D. School Board	71/5	31.62	104	54.55	12			3.04	10
		D.M.A.H.	68/6	46.82	154	31.82	7			3.04	10
		Comm. Comfort	71/3	--	--	13.64	3			--	--
		Comm. Comfort	71/3	34.35	113	13.64	3			7	23
		D.M.A.H.	68/5	47.12	155	36.37	8			3.04	10
		Community Council	71/2	57.12	188	9.09	2			1.83	6

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water Quality</u>	<u>Water Level Metres</u>	<u>Overburden Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
Summerford	660200 5484500	N.D.B. Fisheries	71/3	57.15	188	4.54	1			6.38	21
		Bruce Adams	77/7	40.13	132	2.27	½		3.34	3.65	12
		Water Supply Committee	71/10	45.6	150	--	--			1.83	6
		Water Supply Committee	71/10	45.6	150	13.64	3			1.52	5
		--	71/10	45.6	150	3.41	¾			1.52	5
		Water Supply Committee	71/10	45.6	150	--	--			1.52	5
		Pente- costal Church	76/10	45.6	150	3.41	¾			1.83	6
		Water Supply Committee	72/1	45.6	150	2.27	½			2.43	8
		Harvey Dawe Limited	69/11	18.24	60	Nil	Nil			8.51	28
		Harvey Dawe Limited	69/11	18.24	60	Nil	Nil			3.34	11
		Committee Council	70/2	148.35	488	Nil	Nil			2.58	8.5
		Pente- costal School Board	71/10	65.35	215	25	5½			1.83	6

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Depth</u>		<u>Yield</u>		<u>Water</u> <u>Quality</u>	<u>Water</u> <u>Level</u> <u>Metres</u>	<u>Overburden</u> <u>Thickness</u>	
				<u>Metres</u>	<u>Feet</u>	<u>L/m</u>	<u>Gpm.</u>			<u>Metres</u>	<u>Feet</u>
		Gerald Rideout	76/9	47.12	155	3.41	3/4			2.13	7
		Water Supply Committee	71/11	21.28	70	Nil	Nil			2.43	8
		Harvey Dawe Limited	69/12	25.23	83	Nil	Nil			1.98	6½
		Pente-costal High School	--	21.28	70	--	--			--	--
<u>Embree</u>	643500 5462200	Town	---	33.44	110			2-3		3.04	10
		Town	---	25.23	83			2-3		1.52	5
		Town	---	48.03	158			8		4.56	15
		---	67/6	36.78	121			---		3.04	10
		Ed Janes	---	39.52	130			---		5.47	18
		---	67/5	31.00	102					3.04	10
		Town	74/3	30.4	100			2-3		2.43	8

TABLE A-15

Water Wells Drilled in the Springdale Group

<u>Community</u>	<u>Location</u> E N	<u>Owner</u>	<u>Date</u>	<u>Metres</u>		<u>Feet</u>	<u>Yield</u> L/m	<u>Gpm.</u>	<u>Water</u> Quality	<u>Water</u> Level		<u>Overburden</u> Thickness	
				Metres	Feet					Metres	Feet	Metres	Feet
Springdale	567200	Dept. of Trans. & Comm.	75/10	22.19	73		27.28 - 31.82	6-7					
	5483200												
		Green Bay School Board	76/9	72.95	240							4.27	14
Sprinadale Junction	553200	A.J. Penny	70/10	93.63	308		4.54	1				38.87	118
	5481300												
		Imperial Oil Service Station	68/1	24.32	80		--	--				9.12	30

APPENDIX B: REFERENCES

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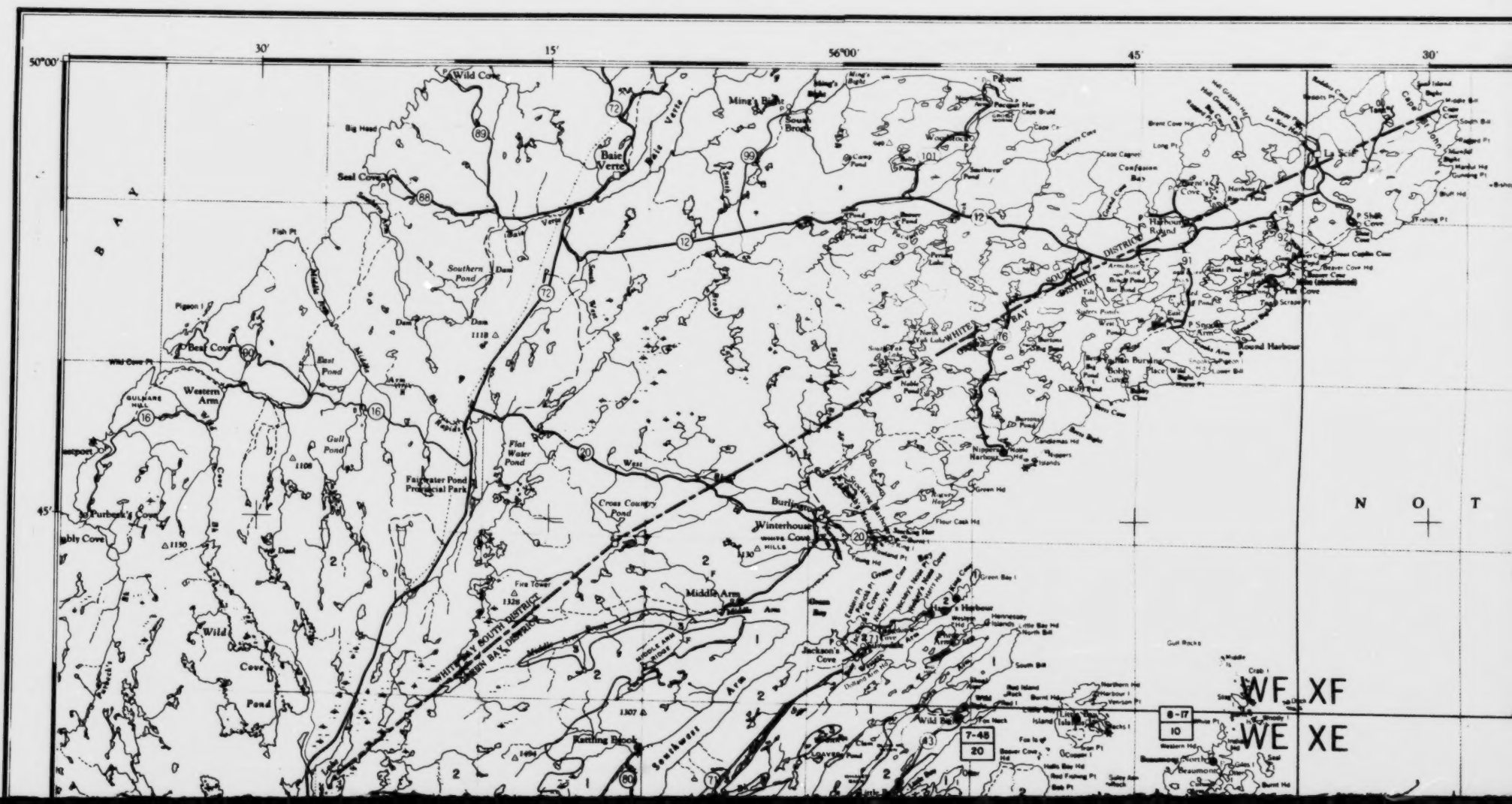
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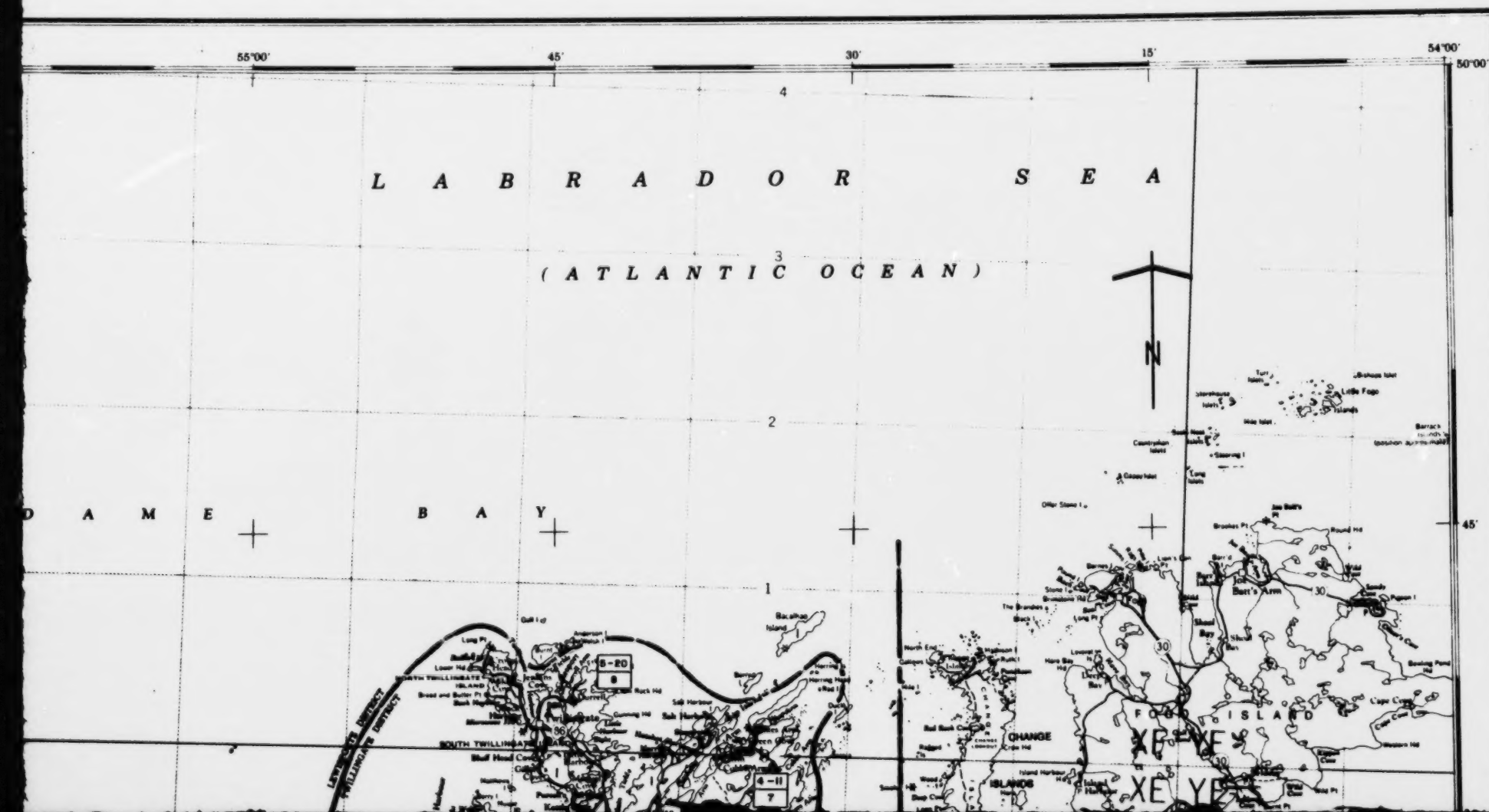
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LEGEND

Surficial Hydrogeologic Unit	Yield Potential	Type of Material
1	Nil - Low	Thin glacial till and/or bedrock.
2	Low - Moderate	Glacial till, comprising thick ground and ablation material.







LEGEND

Surficial Hydrogeologic Unit	Yield Potential	Type of Material
1	Nil - Low	Thin glacial till and/or bedrock.
2	Low - Moderate	Glacial till, comprising thick ground and ablation moraine, with granular interbeds.
3	Moderate - High	Outwash, deltaic, glacio-fluvial, raised beaches and recent alluvium.
4-1	Nil	Marsh and bog decomposed materials, overlying glacio-fluvial deposits.
4-2	Nil	Marsh and bog materials, overlying till deposits.

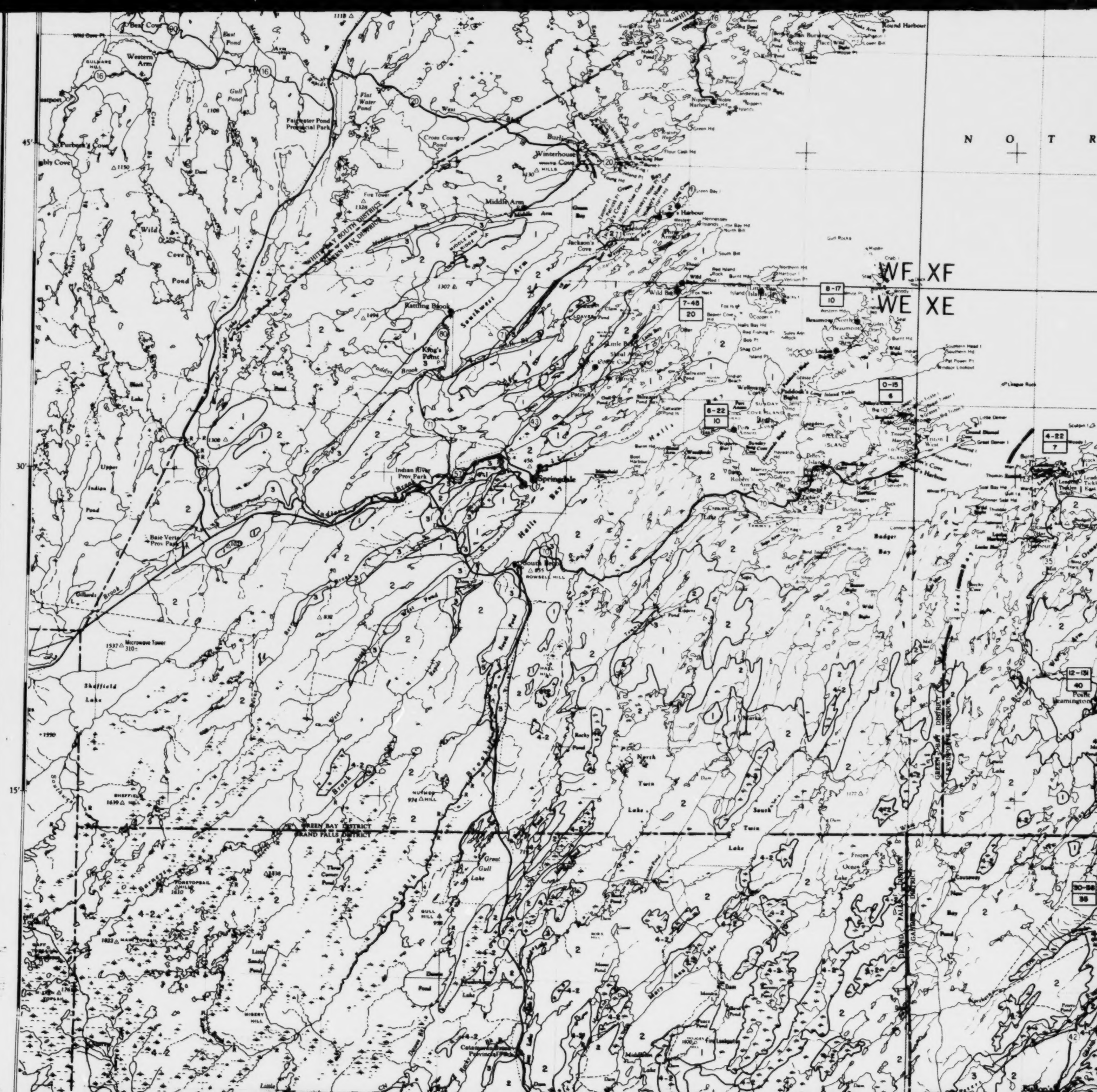
Yield potential are defined as follows:

Low	0 - 3 Gpm (0 - 15 L/min) Difficulty is encountered in obtaining sufficient water for other than domestic purposes.
Moderate	3 - 10 Gpm (15 - 45 L/min) Groundwater supplies are generally adequate for domestic and livestock purposes.
High	10 - 100 Gpm (45 - 450 L/min) Groundwater supplies are adequate for domestic and livestock purposes and for most commercial, communal and small industrial purposes.

Drilled Well Groupings

- Up to five wells
- Up to ten wells
- Hydrogeological boundary

0-20	Range	Overburden thickness
5	Average	





N O T R E D A M E B A Y

WE XF
WE XE

FOG ISLA
XF XE
XE YE

BAY OF EXPLOITS

INDIAN

HAMILTON SOUND

GANDER

BAY

LOON

BAY

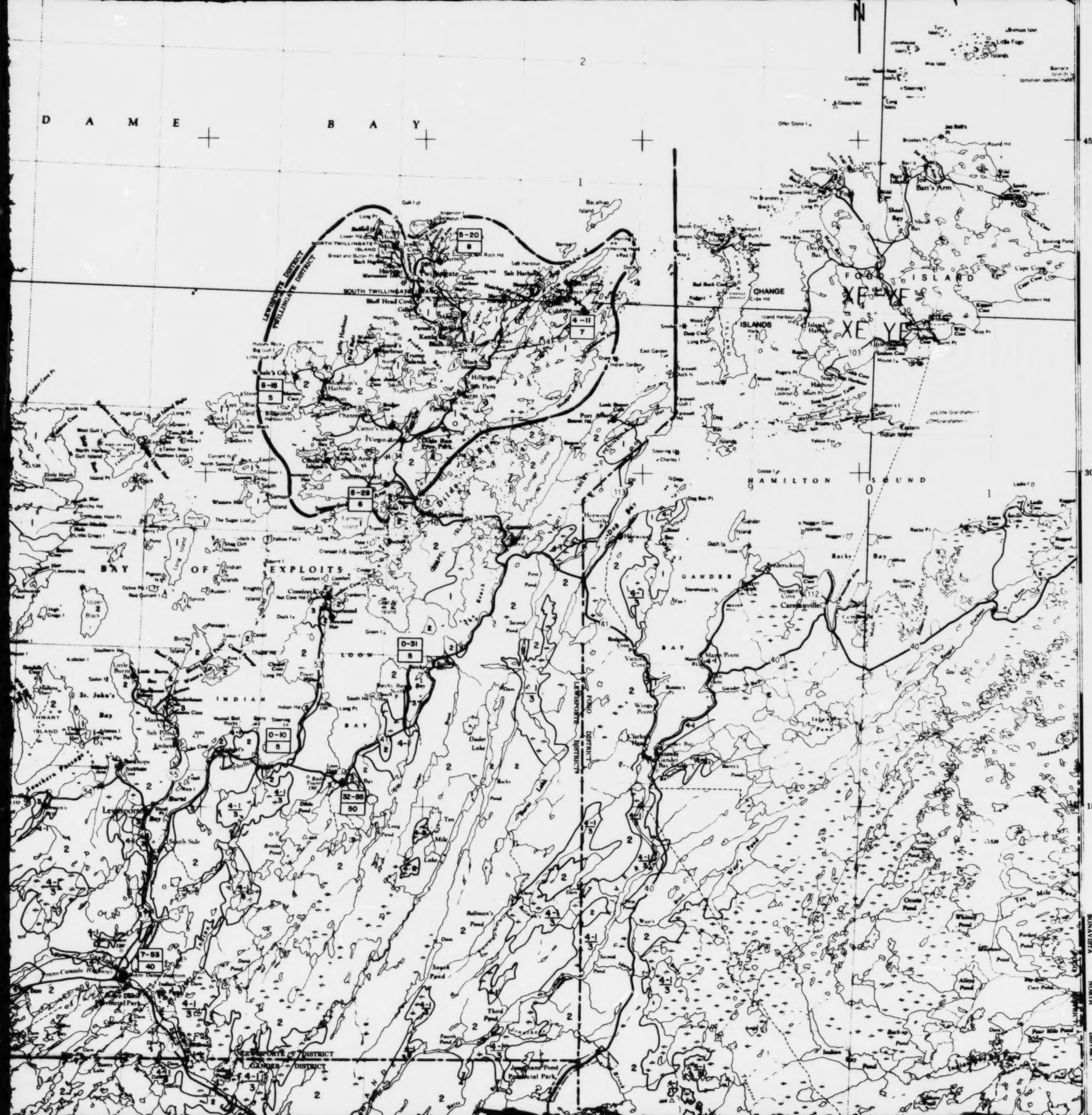
LOON

BAY

LOON

BAY

LOON



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SURFICIAL HYDROGEOLOGY

HYDROGEOLOGICAL STUDY - NOTRE DAME BAY AREA

1980

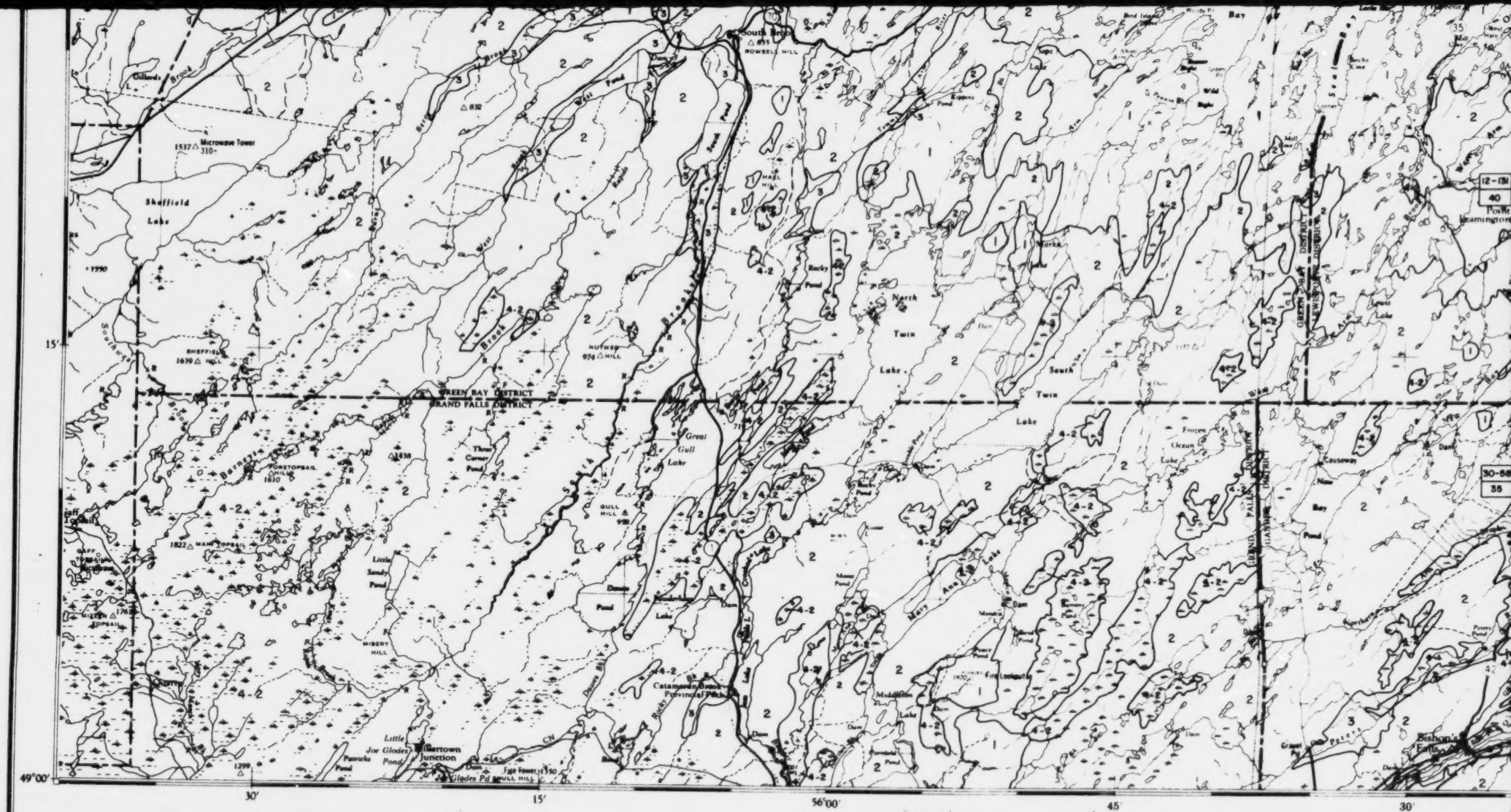
MAP 1

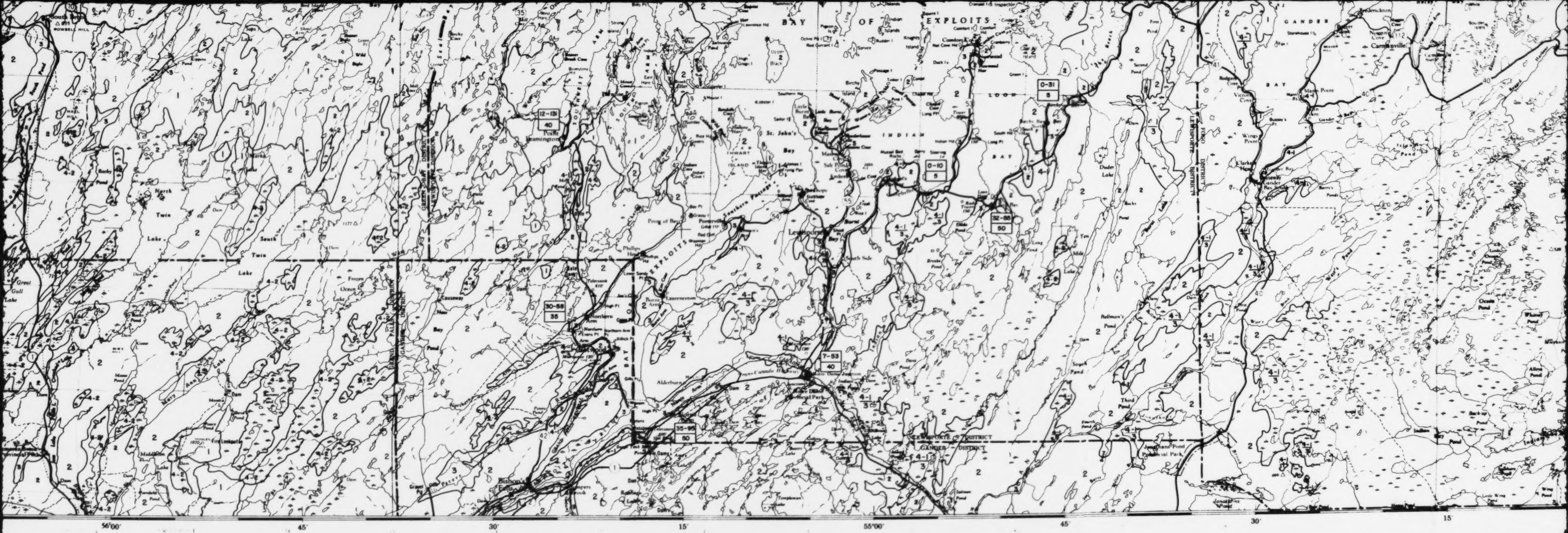
- Low 0 - 5 Gpm (0 - 15 L/min)
Difficulty is encountered in obtaining sufficient water for other than domestic purposes.
- Moderate 3 - 10 Gpm (15 - 45 L/min)
Groundwater supplies are generally adequate for domestic and livestock purposes.
- High 10 - 100 Gpm (45 - 450 L/min)
Groundwater supplies are adequate for domestic and livestock purposes and for most commercial, communal and small industrial purposes.

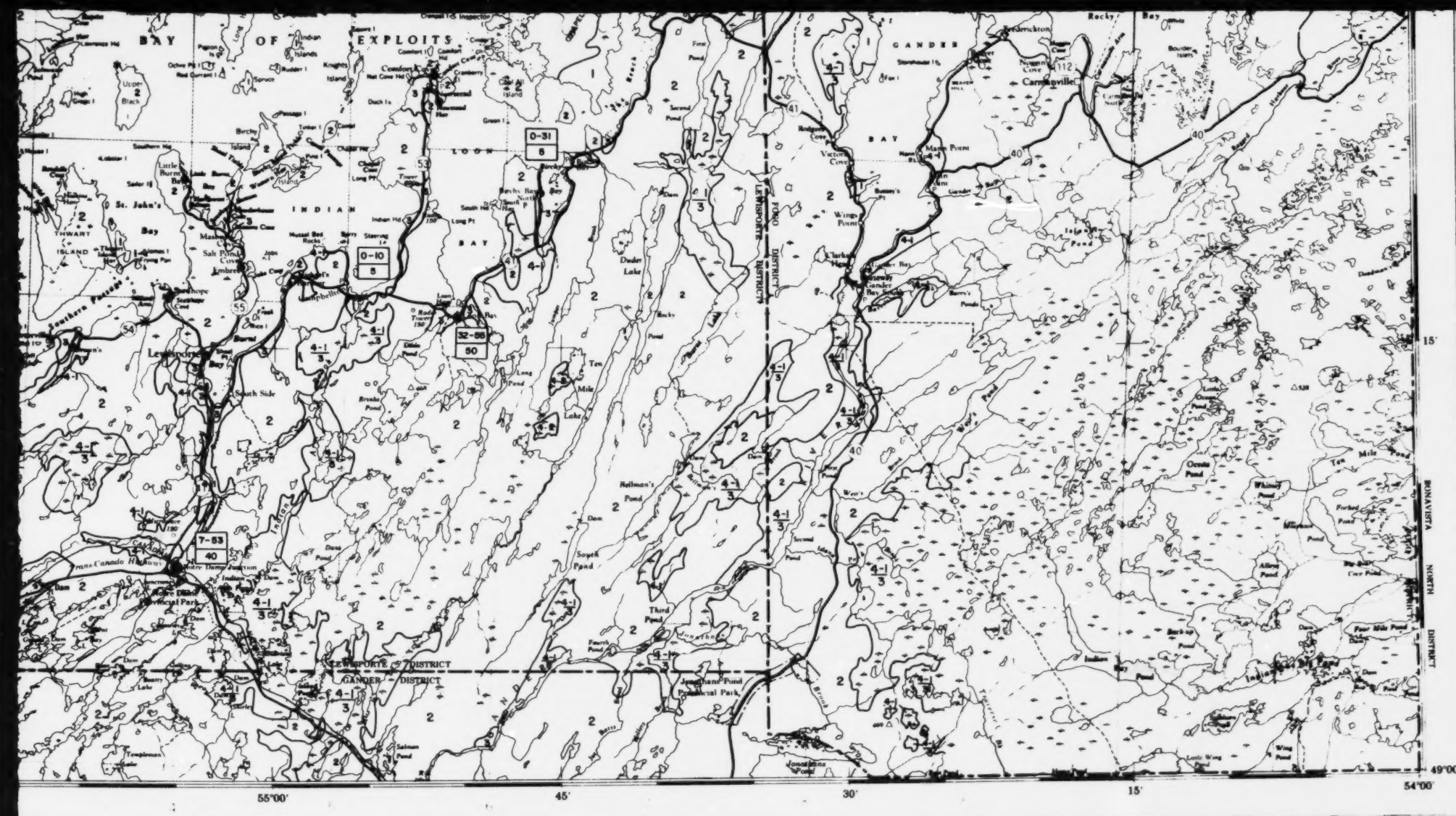
Drilled Well Groupings

- Up to five wells
- Up to ten wells
- Hydrogeological boundary

0-20	Range	Overburden thickness
5	Average	







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GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

SURFICIAL HYDROGEOLOGY

HYDROGEOLOGICAL STUDY - NOTRE DAME BAY AREA

1980

MAP 1



HYDROLOGY CONSULTANTS LIMITED

LEGEND

SYMBOLS

Geological Contact /

Fault (defined, inferred) - - -

PLUTONIC ROCKS

JURASSIC

11

Medium to coarse grained analcite gabbro, hornblende gabbro, hornblende pyroxenite, biotite gabbro, and associated lamprophyre dykes.

DEVONIAN AND YOUNGER

9

Medium to fine grained, pale red to grey, granite, quartz monzonite and minor granodiorite.

DEVONIAN

8

Brick-red, pink, and grey granodiorite, quartz monzonite and granite.

7

Medium to fine grained diabase, gabbro, amphibolite and diorite.

SILURIAN

5

Fine to medium grained, pink, pinkish-grey to brownish red granitoid rocks.

ORDOVICIAN

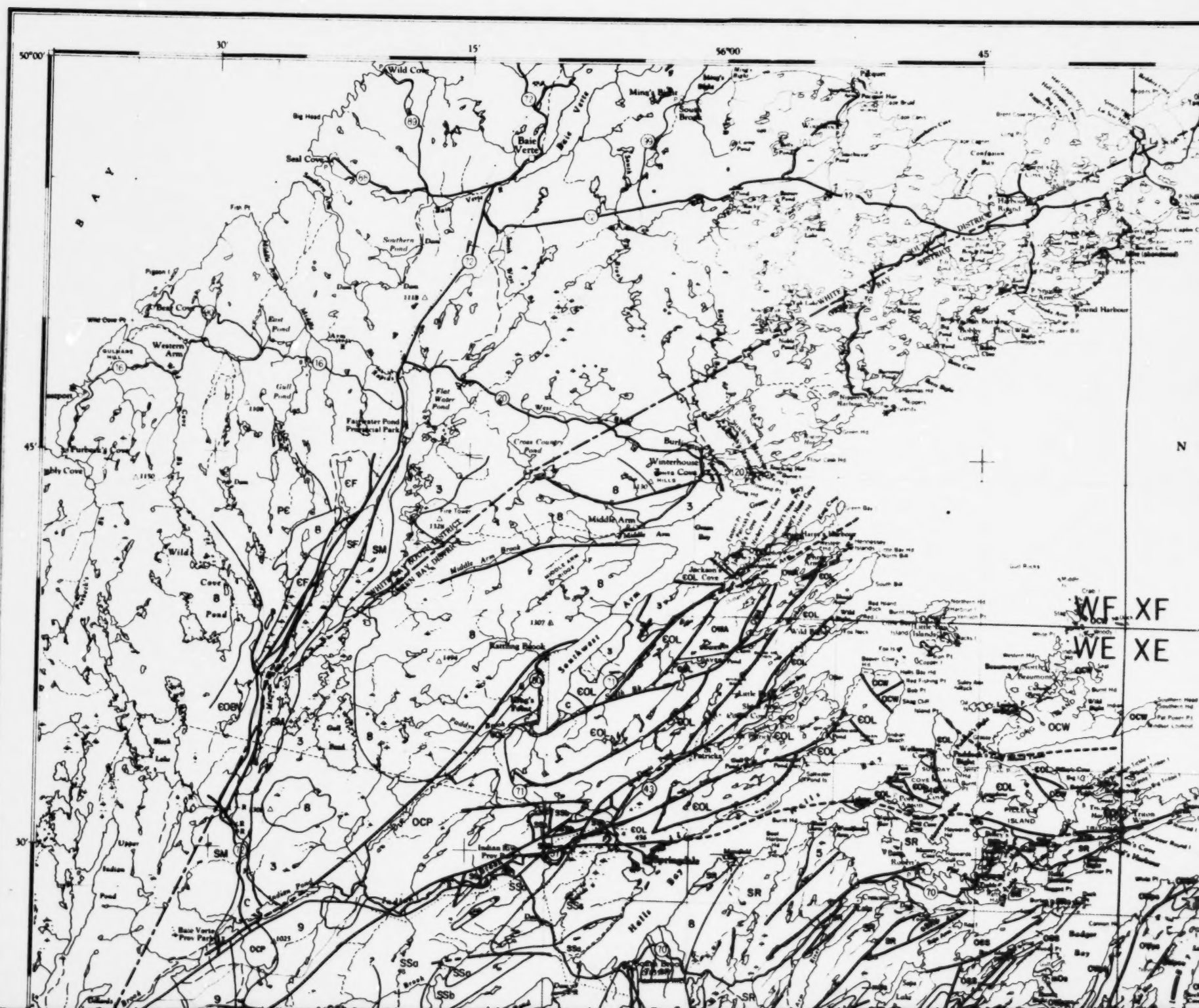
3

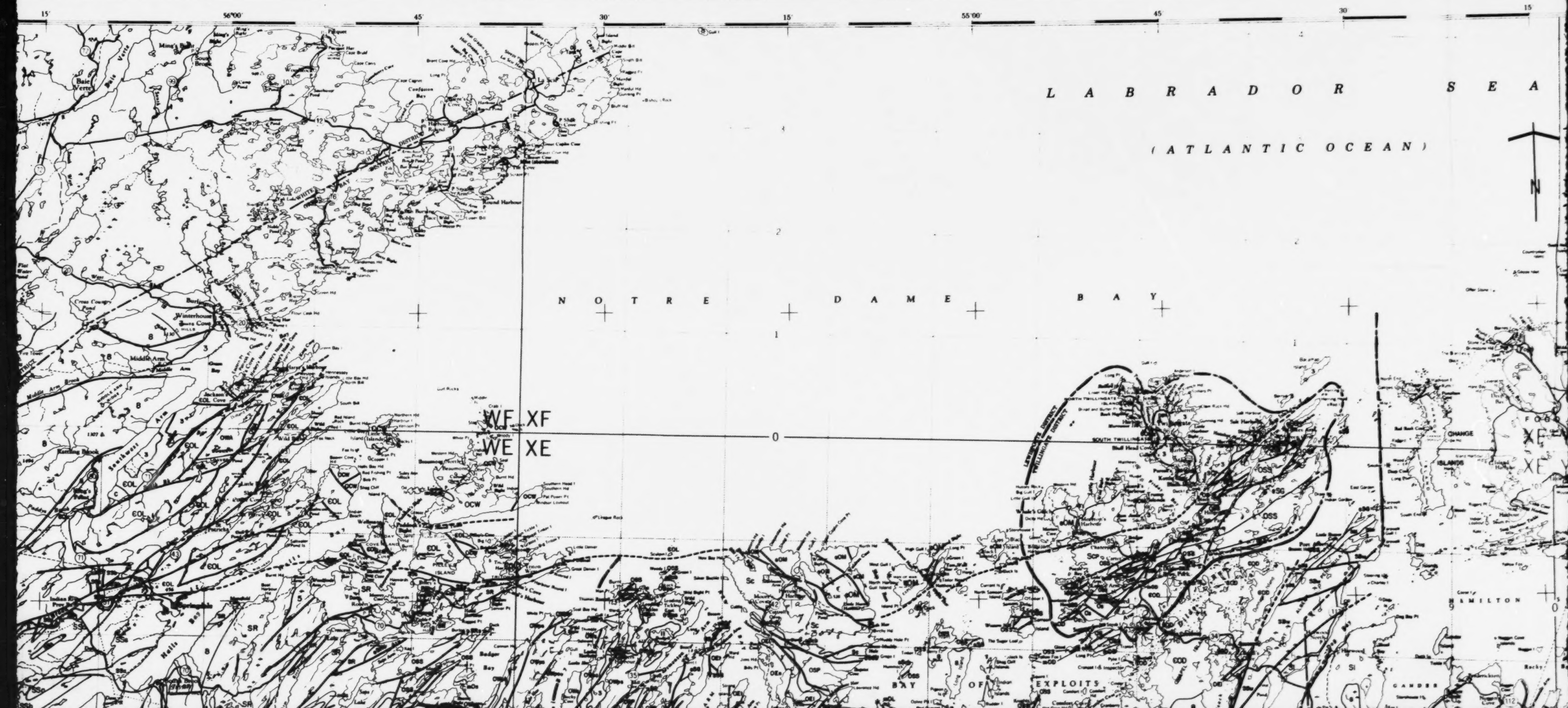
Pink to grey granodiorite to dark greenish-grey gabbro and amphibolite.

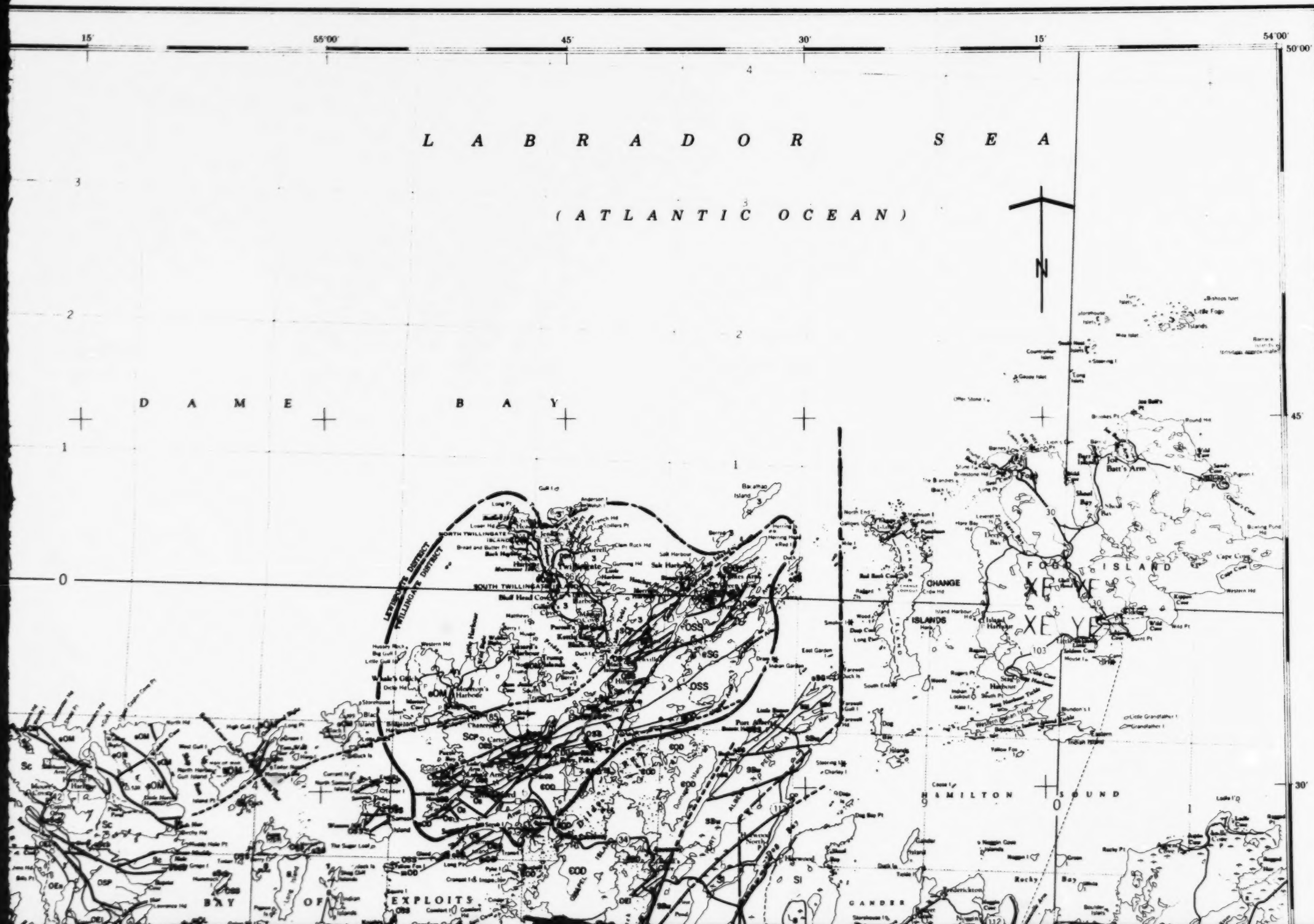
EARLY ORDOVICIAN

2

Brighton Gabbro Complex: very coarse to medium grained hornblende clinopyroxenite and hornblendite intruded by dykes of hornblende gabbro, hornblendite, diorite, quartz diorite, and anorthite.







DEVONIAN AND YOUNGER

- 9 Medium to fine grained, pale red to grey, granite, quartz monzonite and minor granodiorite.

DEVONIAN

- 8 Brick-red, pink, and grey granodiorite, quartz monzonite and granite.

- 7 Medium to fine grained diabase, gabbro, amphibolite and diorite.

SILURIAN

- 5 Fine to medium grained, pink, pinkish-grey to brownish red granitoid rocks.

ORDOVICIAN

- 3 Pink to grey granodiorite to dark greenish-grey gabbro and amphibolite.

EARLY ORDOVICIAN

- 2 Brighton Gabbro Complex: very coarse to medium grained hornblende clinopyroxenite and hornblende intruded by dykes of hornblende gabbro, hornblende, diorite, quartz diorite, and anorthosite.

ORDOVICIAN, SILURIAN AND (?) EARLIER

- 1 Gneissose granitoid rocks, schists and migmatites, and unseparated rocks of unit 8.

SEDIMENTARY AND METAMORPHIC ROCKS

CARBONIFEROUS

- C Poorly indurated red and grey conglomerate and sandstone, grey shale and siltstone, and minor limestone.

SILURIAN AND/OR DEVONIAN MIC MAC LAKE GROUP

- SM Predominantly red to grey rhyolite flows, tuff and agglomerate; unseparated, dark amygdaloidal basalt flows; minor fine conglomerate and sandstone.

SPRINGDALE GROUP

- SSs Brownish-grey to reddish-brown conglomerate, sandstone, siltstone and mudstone.
SSa Pale red and greyish-red rhyolite and trachyte flows, tuff and agglomerate.
SSb Grey, red and purple amygdaloidal andesite and basalt flows.

FLATWATER GROUP

- SF Basic pillow lava, tuff, agglomerate, and argillaceous rocks.

ROBERT'S ARM GROUP

- SR Predominantly greyish-green intermediate to basic pillow lava, with coarse volcanic breccia and agglomerate; greenish-grey rhyolite and dacite flows; grey bedded tuff, chert, greywacke and black shale.

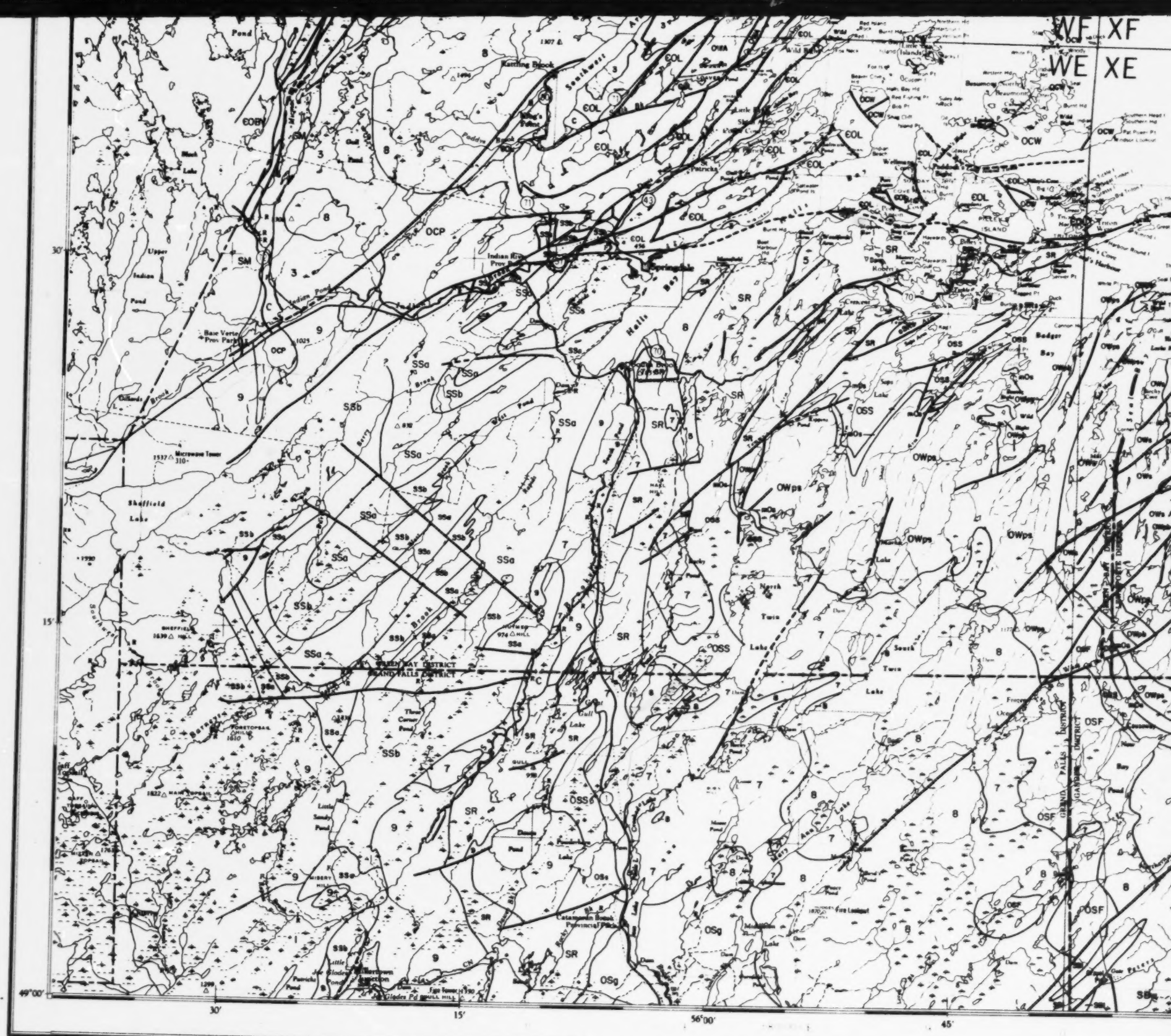
- eSRs SOPS'S HEAD COMPLEX: Chaotically slumped, black and grey argillite, basic flows, tuff, greywacke, limestone, and chert.

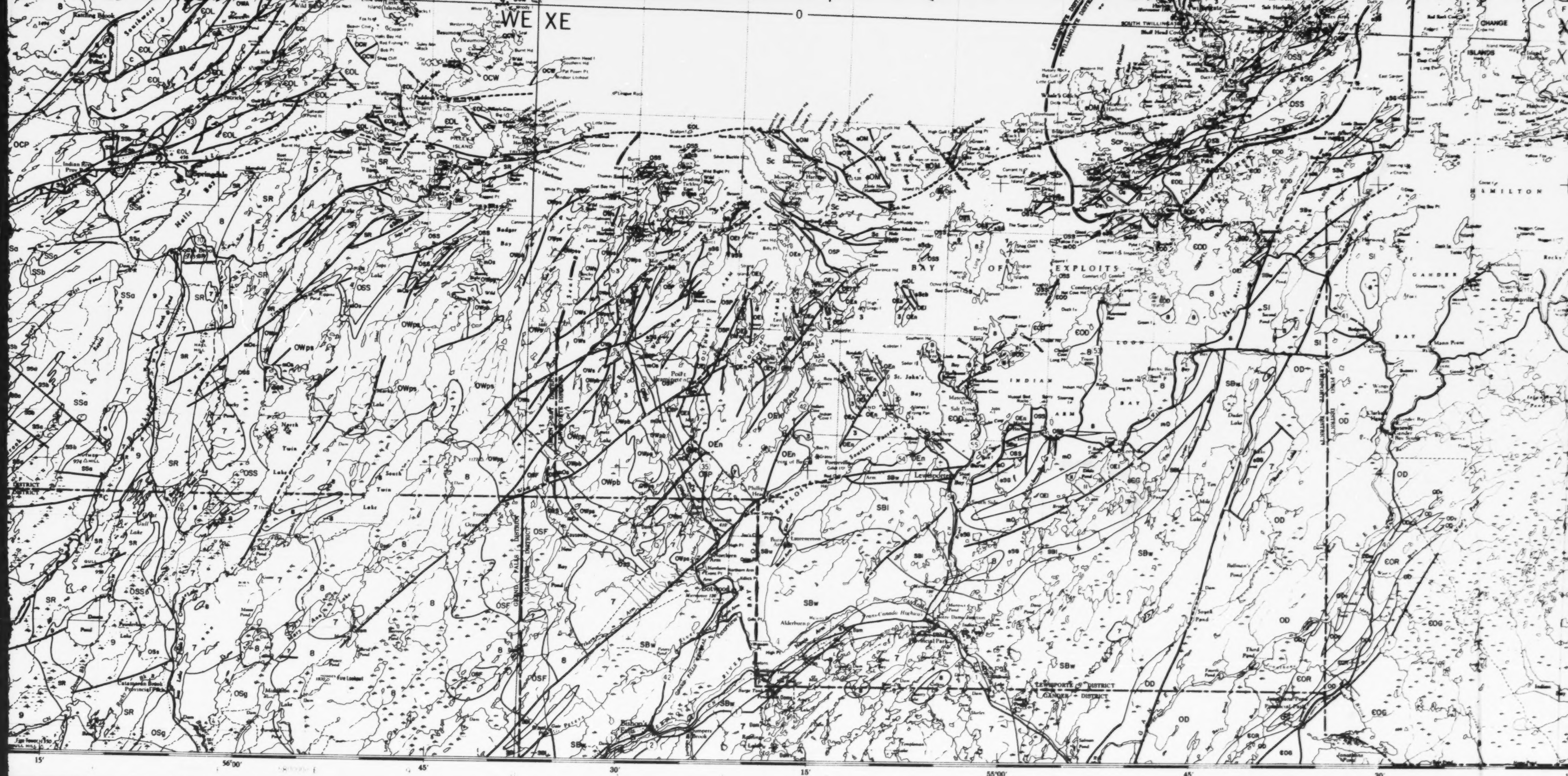
BUCHAN'S GROUP

- OSv Pillow lava, intraformational breccias and red cherts. OSg Greywacke and conglomerate. (GOLDSON AND SANSON undivided)

FROZEN OCEAN GROUP

- OSF Dark green to light green basic pillow lava, pillow breccia and flows; purple to red and green acidic flows; and black to red chert.





wa, intraformational breccias
OSg. Greywacke and
GOLDSON AND SANSON undivided).

FROZEN OCEAN GROUP

OSF Dark green to light green basic pillow lava, pillow breccia and flows; purple to red and green acidic flows and pyroclastic rocks, bedded tuff, tuffaceous sandstone and agglomerate.

COTTRELL'S COVE GROUP

Sc Volcanic and sedimentary rocks; green and red pillow lava and pillow breccia with interstitial chert and limestone; coarse to fine grained acidic pyroclastic rocks, bedded tuff, red and green chert and rhyolite flows; tuffaceous sandstone, slate, argillite, greywacke, thin lava flows, and red chert.

aScb BOONES POINT COMPLEX: Chaotically slumped black and grey argillite, basic volcanic flows, tuff, greywacke, conglomerate, limestone and chert.

CHANCEPORT GROUP

Scp Reddish-brown to black and green pillow lava with abundant interpillow chert; grey to black greywacke, siliceous argillite, tuffaceous greywacke and quartzite; white, red and green chert, bedded tuffs and quartzose greywacke.

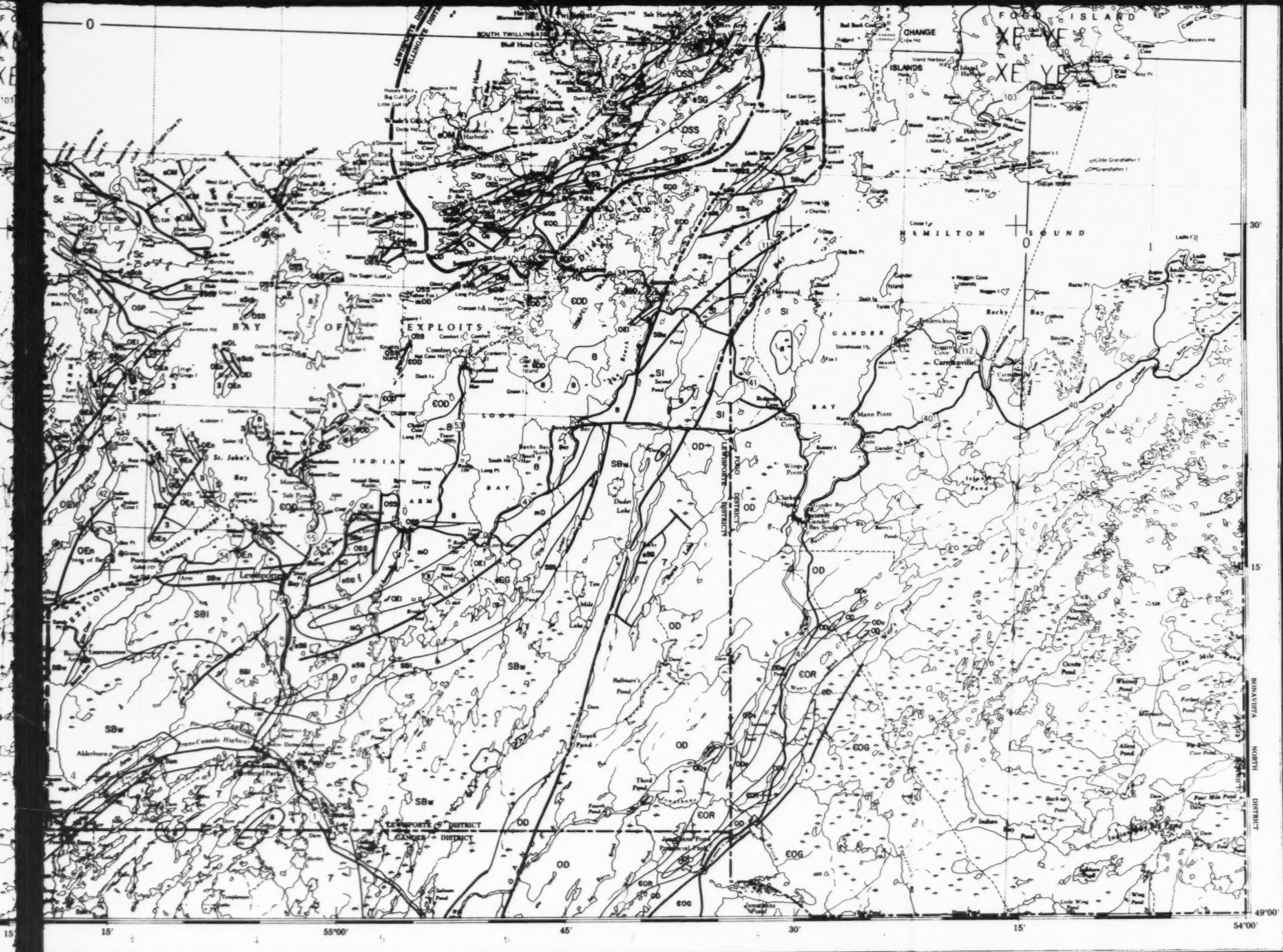
SILURIAN BOTWOOD GROUP

SBw WIG WAM FORMATION: Red, brown and green sandstone, siltstone and quartzite, minor acidic pyroclastic rocks and vesicular basalt.

SBI LAWRENCETON FORMATION: Coarse acidic to agglomerate, crystal and lithic tuff; purple green and black amygdaloidal lava.

GOLDSON CONGLOMERATE

aSG Coarse grey and red porphyritic conglomerate, grey sandstone and quartzite, some green lentils within the conglomerate.



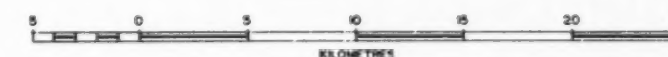
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BEDROCK GEOLOGY

HYDROGEOLOGICAL STUDY - NOTRE DAME BAY AREA

1980

MAP 2



HYDROLOGY CONSULTANTS LIMITED

CHANCEPORT GROUP

SCP Reddish-brown to black and green pillow lava with abundant interpillow chert; grey to black greywacke, siliceous argillite, tuffaceous greywacke and quartzite; white, red and green chert, bedded tuffs and quartzose greywacke.

SILURIAN BOTWOOD GROUP

SBw WIG WAM FORMATION: Red, brown and green micaceous sandstone, siltstone and quartzite, minor unseparated acidic pyroclastic rocks and vesicular basalt.

SBI LAWRENCETON FORMATION: Coarse acidic to intermediate agglomerate, crystal and lithic tuff; purple, red, green and black amygdaloidal lava.

GOLDSON CONGLOMERATE

e98 Coarse grey and red polymictic conglomerate, grey sandstone and quartzite, some greywacke lentils within the conglomerate.

INDIAN ISLANDS GROUP

SI Predominantly interbedded grey slates and siltstone, some grey pebbly mudstone and conglomerate with feldspathic and lithic greywacke; minor thin units of acidic pyroclastic rocks and minor coralline

ary rocks; green and red pillow
cia with interstitial chert and
fine grained acidic pyroclastic
red and green chert and rhyolite
stone, slate, argillite, grey-
s, and red chert.

Chaotically slumped black and
volcanic flows, tuff, grey-
limestone and chert.

SEDIMENTARY AND METAMORPHIC ROCKS

CARBONIFEROUS

- C** Poorly indurated red and grey conglomerate and sandstone, grey shale and siltstone, and minor limestone.

SILURIAN AND/OR DEVONIAN MIC MAC LAKE GROUP

- SM** Predominantly red to grey rhyolite flows, tuff and agglomerate; unseparated, dark amygdaloidal basalt flows; minor fine conglomerate and sandstone.

SPRINGDALE GROUP

- SSs** Brownish-grey to reddish-brown conglomerate, sandstone, siltstone and mudstone.
- SSa** SSa. Pale red and greyish-red rhyolite and trachyte flows, tuff and agglomerate.
- SSb** SSb. Grey, red and purple amygdaloidal andesite and basalt flows.

FLATWATER GROUP

- SF** Basic pillow lava, tuff, agglomerate, and argillaceous rocks.

ORDOVICIAN AND SILURIAN

MIDDLE ORDOVICIAN

SNOOKS ARM, CATCHERS POND, WESTERN ARM, AND CUTWELL GROUPS

- OSA** **OCP** **OWA** **OCW**
- Basic to intermediate pillow lava, tuff, agglomerate, and breccia, with some argillite and chert; acidic volcanic rocks are predominant in the Catchers Pond Group.

ROBERT'S ARM GROUP

- SR** Predominantly greyish-green intermediate to basic pillow lava, with coarse volcanic breccia and agglomerate; greenish-grey rhyolite and dacite flows; grey bedded tuff, chert, greywacke and black shale.

- SRs** SOPS'S HEAD COMPLEX: Chaotically slumped, black and grey argillite, basic flows, tuff, greywacke, limestone, and chert.

SANSOM GREYWACKE

- OSs** Medium grey, well bedded, graded greywacke, commonly chaotically slumped; local conglomeratic horizons near top and bottom of the formation.

SHOAL ARM FORMATION

- mos** Red, green and black chert, black carbonaceous argillite and argillaceous siltstone, minor acidic tuff.

WILD BIGHT GROUP

- OWp** PENNY'S BROOK FORMATION: OWpa. acidic pyroclastic and volcanic flow rocks. OWpb. pillow lava, pillow breccia, basic flows and agglomerates. OWps. red and green, thin bedded tuff, green thick bedded lapilli tuff; tuffaceous sandstone, greywacke, argillite and chert.

- OWs** Volcanic and sedimentary rocks of the SIDE HARBOUR SPAL BAY BROOK, SPARROW COVER, AND OMEGA POINT FORMATIONS: Basic flows, pillow lava, and pillow breccia; tuff, greywacke and chert.

LUSH'S BIGHT GROUP

- COL** Dark to light green, massive to pillow basalt, pillow breccia, aquagene tuff and chert; dark grey pillow basalt, sheeted diabase dykes and gabbro.

BUCHANS GROUP

- OSv** **OSg** OSv. Pillow lava, intraformational breccias and red cherts. OSg. Greywacke and conglomerate (GOLDSON AND SANSOM undivided).

FROZEN OCEAN GROUP

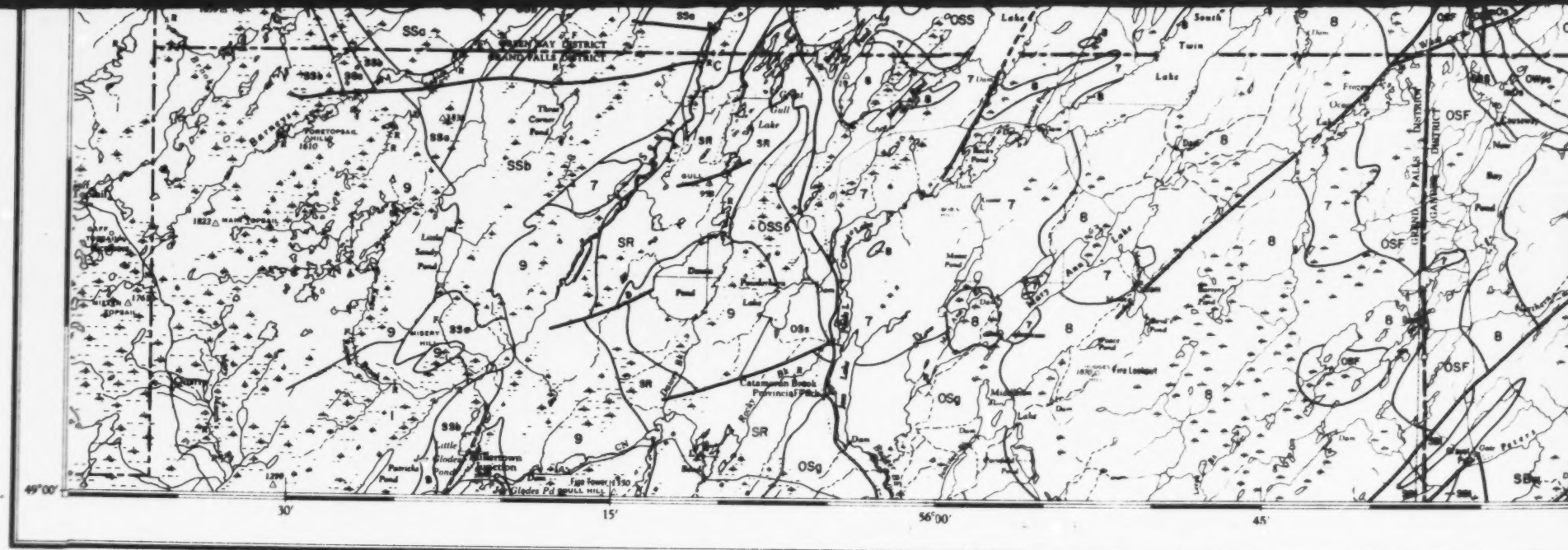
- OSF** Dark green to light green basic pillow lava, pillow breccia and flows; purple to red and green acidic flows and pyroclastic rocks, bedded tuff, tuffaceous sandstone and agglomerate.

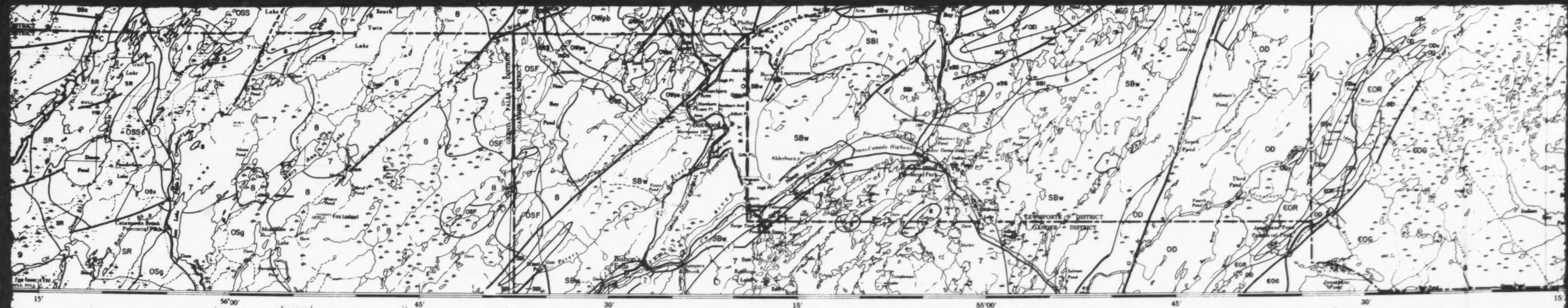
LATE PRECAMBRIAN TO CAMBRIAN FLEUR DE LYS SUPERGROUP

- EF** Biotite-muscovite schist and gneiss.

PRECAMBRIAN GRENVILLE

- PE** Biotite-hornblende schist and gneiss; granite gneiss; minor metagabbro.





lava, intraformational breccias
OSg. Greywacke and
GOLDSON AND SANSOM undivided).

FROZEN OCEAN GROUP

OSF

Dark green to light green basic pillow lava, pillow breccia and flows; purple to red and green acidic flows and pyroclastic rocks, bedded tuff, tuffaceous sandstone and agglomerate.

COTTRELL'S COVE GROUP

Sc

Volcanic and sedimentary rocks; green and red pillow lava and pillow breccia with interstitial chert and limestone; coarse to fine grained acidic pyroclastic rocks, bedded tuff, red and green chert and rhyolite flows; tuffaceous sandstone, slate, argillite, greywacke, thin lava flows, and red chert.

eScb

BOONES POINT COMPLEX: Chaotically slumped black and grey argillite, basic volcanic flows, tuff, greywacke, conglomerate, limestone and chert.

POINT LEAMINGTON GREYWACKE

OSP

Grey to black, thinly bedded greywacke and silty argillite, commonly chaotically slumped; some conglomerate lentils within greywacke.

mO

Black carbonaceous argillite and argillaceous siltstone; locally chert at base.

EXPLOITS GROUP

OEI

LAWRENCE HEAD AND LOONS HARBOUR VOLCANICS: Dark green basic pillow lava, basic to acidic pyroclastic rocks, and columnar basalt.

OEn

NEW BAY FORMATION: Buff-weathering graded sandstone and conglomeratic turbidites; dark grey silty shale thinly bedded and laminated red and green cherty argillite and tuff; tuffaceous sandstone, greywacke and conglomerate.

CHANCEPORT GROUP

Scr

Reddish-brown to black and green pillow lava with abundant interpillow chert; grey to black greywacke, siliceous argillite, tuffaceous greywacke and quartzite; white, red and green chert, bedded tuffs and quartzose greywacke.

DARK HOLE FORMATION

mOD

Black carbonaceous, siliceous argillite and argillaceous siltstone, locally, chert and tuff at the base (includes ROGERS COVE SHALE)

SUMMERFORD GROUP

Os

Dark green to pale green pillow lava, massive basalt, plagioclase porphyritic lava, pillow breccia and agglomerate, minor interstitial limestone pods and tuffaceous siltstone; limy tuff and shale, feldspathic greywacke, tuffaceous siltstone and argillite (includes the Cobb's Arm Limestone).

MORETON'S HARBOUR GROUP

eOM

Pale green to dark green pillow lava with minor layers of pillow breccia, acidic tuff and chert; coarse to fine grained diabase dykes with minor screens of pillow lava and plagioclase - clinopyroxene porphyritic lava.

SILURIAN BOTWOOD GROUP

SBw

WIG WAM FORMATION: Red, brown and green sandstone, siltstone and quartzite, minor acidic pyroclastic rocks and vesicular basalt.

SBI

LAWRENCETON FORMATION: Coarse acidic to agglomerate, crystal and lithic tuff; purple green and black amygdaloidal lava.

GOLDSON CONGLOMERATE

eSG

Coarse grey and red polymictic conglomerate, grey sandstone and quartzite, some greywacke lentils within the conglomerate.

CAMBRIAN TO MIDDLE ORDOVICIAN DUNNAGE MELANGE

EOO

Black to green chaotically mixed argillite pebbly to cobbly mudstone with exotic blocks and boulders of pillow lava, greywacke, bedded sandstone, agglomerate, gabbro, limestone and granite.

SLEEPY COVE GROUP

EOm

Pale to dark green, closely packed pillow lava; diabase dykes; minor green to pink agglomerate and tuff.

BRIAN

te schist and

PRECAMBRIAN GRENVILLE

PG

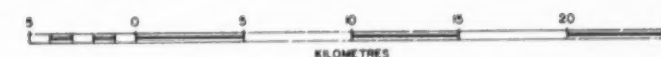
Biotite-hornblende schist and gneiss; granite gneiss; minor metagabbro.

BEDROCK GEOLOGY

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MAP 2



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ary rocks; green and red pillow
cia with interstitial chert and
fine grained acidic pyroclastic
red and green chert and rhyolite
ndstone, slate, argillite, grey-
ws, and red chert.

s Chaotically slumped black and
c volcanic flows, tuff, grey-
limestone and chert.

y bedded greywacke and silty
chaotically slumped; some con-
thin greywacke.

rgillite and argillaceous
hert at base.

NS HARBOUR VOLCANICS: Dark
lava, basic to acidic
nd columnar basalt.
uff-weathering graded sand-
tic turbidites; dark grey
edded and laminated red
illite and tuff; tuffaceous
and conglomerate.

CHANCEPORT GROUP

Scp Reddish-brown to black and green pillow lava with abundant interpillow chert; grey to black greywacke, siliceous argillite, tuffaceous greywacke and quartzite; white, red and green chert, bedded tuffs and quartzose greywacke.

DARK HOLE FORMATION

mOD Black carbonaceous, siliceous argillite and argillaceous siltstone, locally, chert and tuff at the base (includes ROGERS COVE SHALE)

SUMMERFORD GROUP

Os Dark green to pale green pillow lava, massive basalt, plagioclase porphyritic lava, pillow breccia and agglomerate, minor interstitial limestone pods and tuffaceous siltstone; limy tuff and shale, feldspathic greywacke, tuffaceous siltstone and argillite (includes the Cobb's Arm Limestone).

MORETON'S HARBOUR GROUP

eOM Pale green to dark green pillow lava with minor layers of pillow breccia, acidic tuff and chert; coarse to fine grained diabase dykes with minor screens of pillow lava and plagioclase - clinopyroxene porphyritic lava.

SILURIAN BOTWOOD GROUP

SBw WIG WAM FORMATION: Red, brown and green micaceous sandstone, siltstone and quartzite, minor unseparated acidic pyroclastic rocks and vesicular basalt.

SBI LAWRENCETON FORMATION: Coarse acidic to intermediate agglomerate, crystal and lithic tuff; purple, red, green and black amygdaloidal lava.

GOLDSON CONGLOMERATE

eSG Coarse grey and red polymictic conglomerate, grey sandstone and quartzite, some greywacke lentils within the conglomerate.

CAMBRIAN TO MIDDLE ORDOVICIAN DUNNAGE MELANGE

eOD Black to green chaotically mixed argillite, and pebbly to cobbly mudstone with exotic blocks and boulders of pillow lava, greywacke, bedded clastic rocks, agglomerate, gabbro, limestone and granite.

SLEEPY COVE GROUP

COMs Pale to dark green, closely packed pillow lava; diabase dykes; minor green to pink agglomerate and tuff.

INDIAN ISLANDS GROUP

SI Predominantly interbedded grey slates and siltstone, some grey pebbly mudstone and conglomerate with feldspathic and lithic greywacke; minor thin units of acidic pyroclastic rocks and minor coralline shale and limestone.

EARLY ORDOVICIAN TO EARLY SILURIAN DAVIDSVILLE GROUP

OD Grey to black slate and siltstone, greywacke, and minor volcanic rocks.

ODv Massive to pillowed mafic flows, coarse agglomerate and tuff; minor limy tuff and limestone.

CAMBRIAN OR ORDOVICIAN GANDER RIVER ULTRAMAFIC BELT

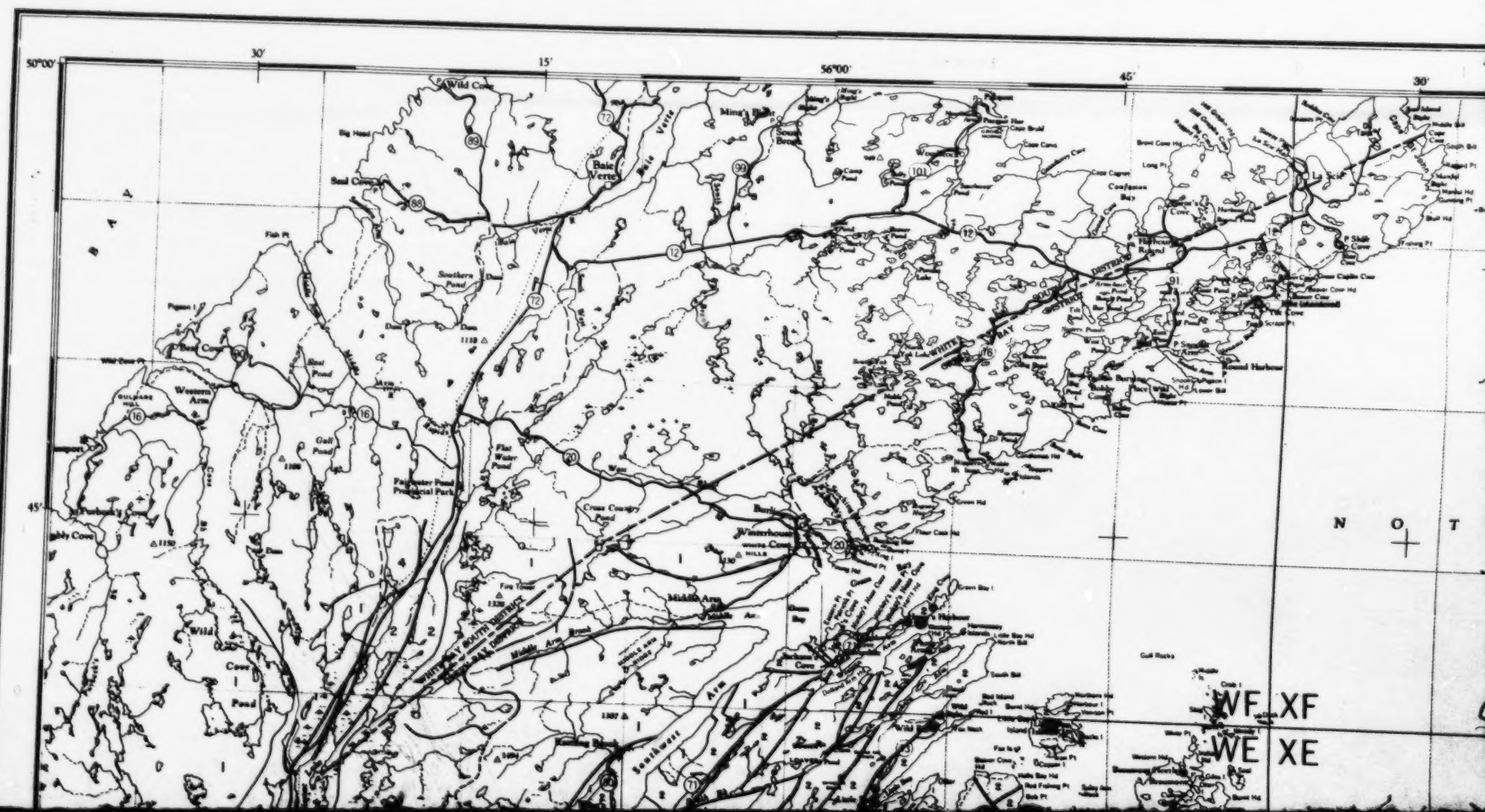
EOR Massive to schistose pyroxenite, serpentinite gabbro and talc-carbonate schist; locally includes mafic volcanics, diabase and sedimentary rocks.

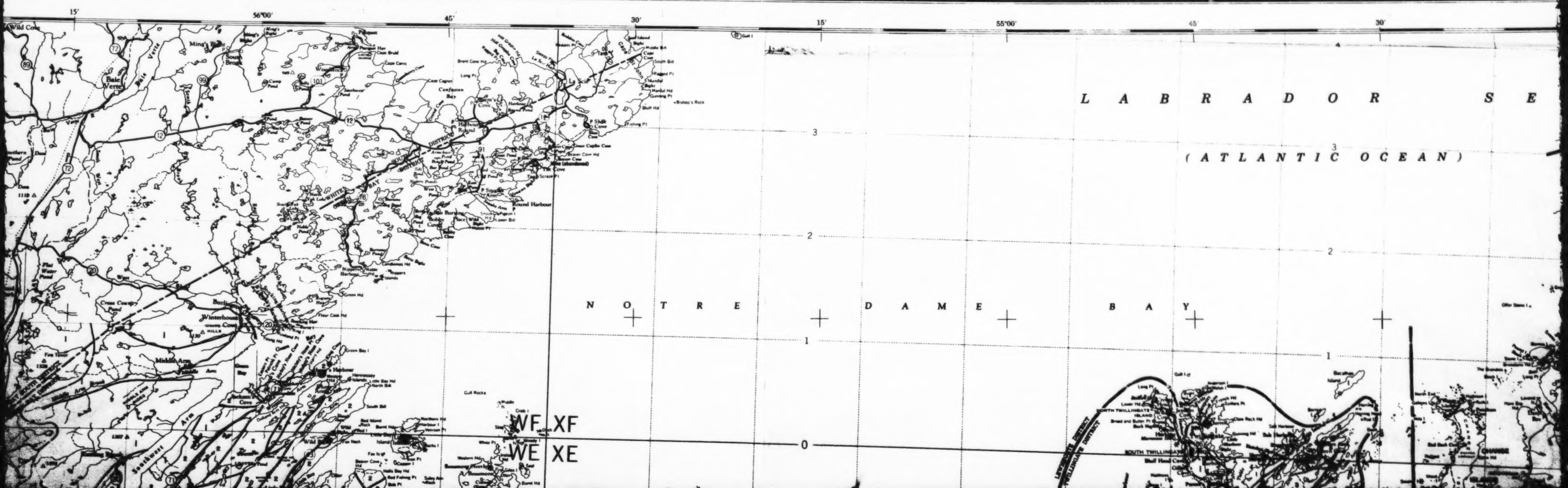
GANDER GROUP

EOG Fine-grained, quartz-feldspar-mica schist; minor quartzite, amphibolite, chlorite schist and mylonite, may include areas of quartz-feldspar gneiss.

LEGEND

Hydrogeological Unit	Yield Potential	Rock Type
1	Low	Igneous intrusives, mainly comprising granite, granodiorite, diorite, gabbro, diabase; of Ordovician to Devonian age.
2	Moderate	Volcanic rocks, mainly comprising basic pillow lava, breccia, flows, agglomerates, tuff; with minor chert, sandstone, greywacke and conglomerate; of Ordovician to Silurian age.
3	Moderate	Sedimentary rocks, mainly comprising bedded argillite, sandstone, siltstone, conglomerate, greywacke, shale; with







LEGEND

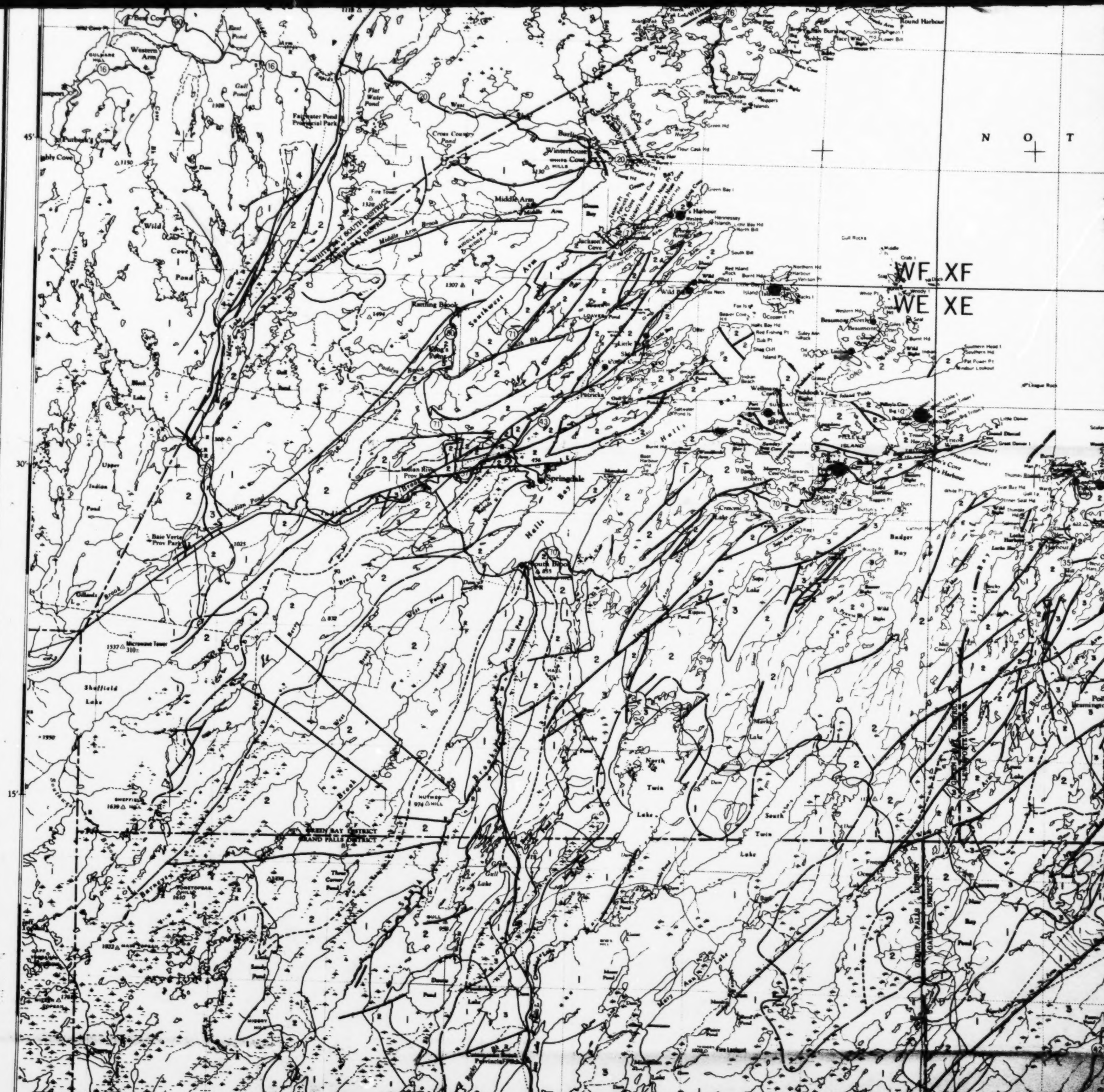
Hydrogeological Unit	Yield Potential	Rock Type
1	Low	Igneous intrusives, mainly comprising granite, granodiorite, diorite, gabbro, diabase; of Ordovician to Devonian age.
2	Moderate	Volcanic rocks, mainly comprising basic pillow lava, breccia, flows, agglomerates, tuff; with minor chert, sandstone, greywacke and conglomerate; of Ordovician to Silurian age.
3	Moderate	Sedimentary rocks, mainly comprising bedded argillite, sandstone, siltstone, conglomerate, greywacke, shale; with minor chert, tuff, and volcanic flows; of Ordovician to Silurian age.
4	Low - Moderate	Metamorphic rocks, mainly comprising schist, gneiss, quartzite, slate; with minor volcanic flows; of Precambrian to Ordovician age.

Yield Potentials are defined as follows:

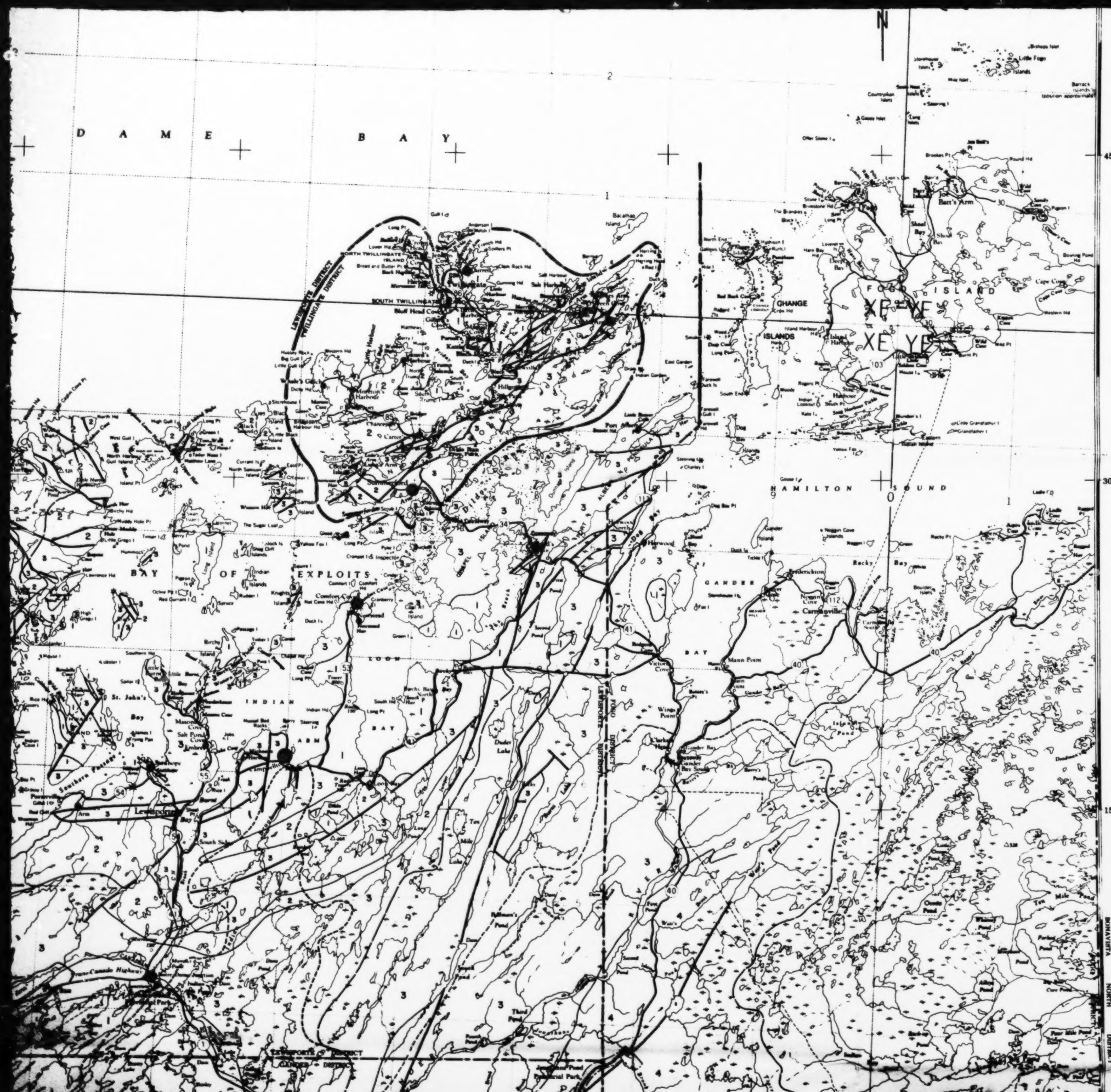
Low	0 - 3 Gpm (0 - 15 L/min) Difficulty is encountered in obtaining sufficient water for other than domestic purposes.
Moderate	3 - 10 Gpm (15 - 45 L/min) Groundwater supplies are generally adequate for domestic and livestock purposes.
High	10 - 100 Gpm (45 - 450 L/min) Groundwater supplies are adequate for domestic and livestock purposes and for most commercial, communal and small industrial purposes.

Drilled Well Groupings

- Up to five wells
- Up to ten wells
- Up to twenty wells
- More than twenty wells
- Hydrogeological Boundary
- Watershed (Basin) Boundary
- Watershed (Sub Basin) Boundary
- - - Fault (defined, inferred)







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MAP 5

Moderate

3 - 10 Gpm (15 - 45 L/min)
Groundwater supplies are generally adequate for domestic and livestock purposes.

High

10 - 100 Gpm (45 - 450 L/min)
Groundwater supplies are adequate for domestic and livestock purposes and for most commercial, communal and small industrial purposes.

Drilled Well Groupings

- Up to five wells
- Up to ten wells
- Up to twenty wells
- More than twenty wells

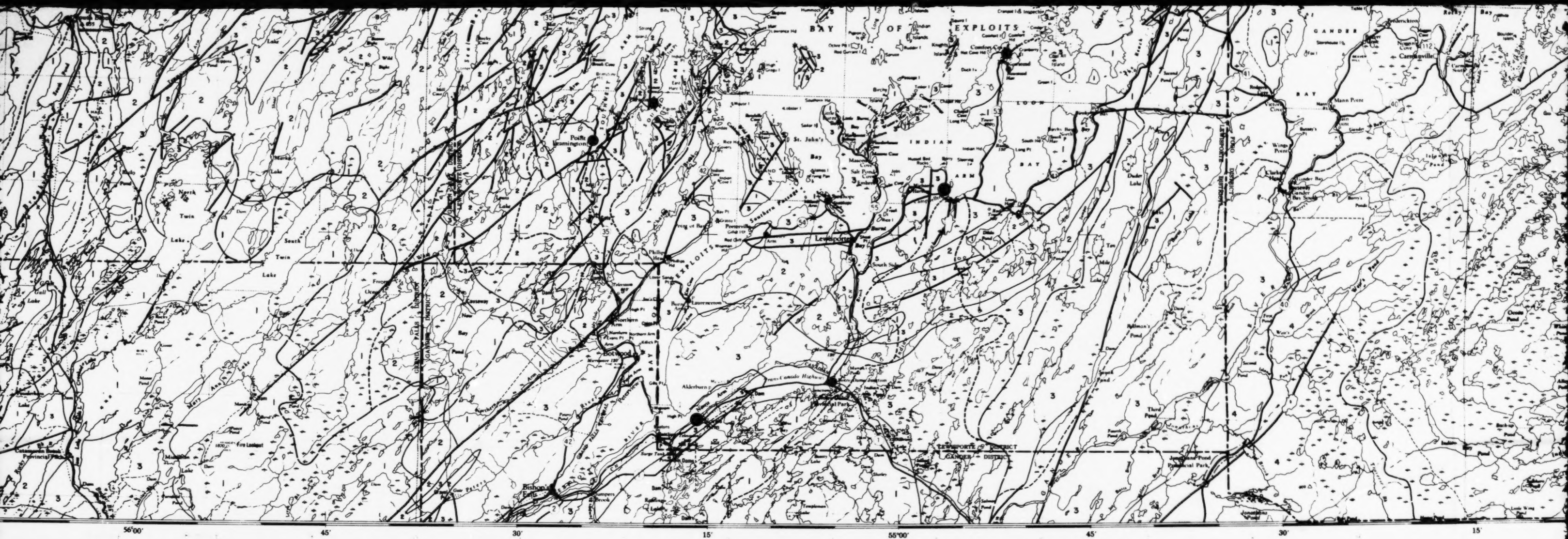
Hydrogeological Boundary

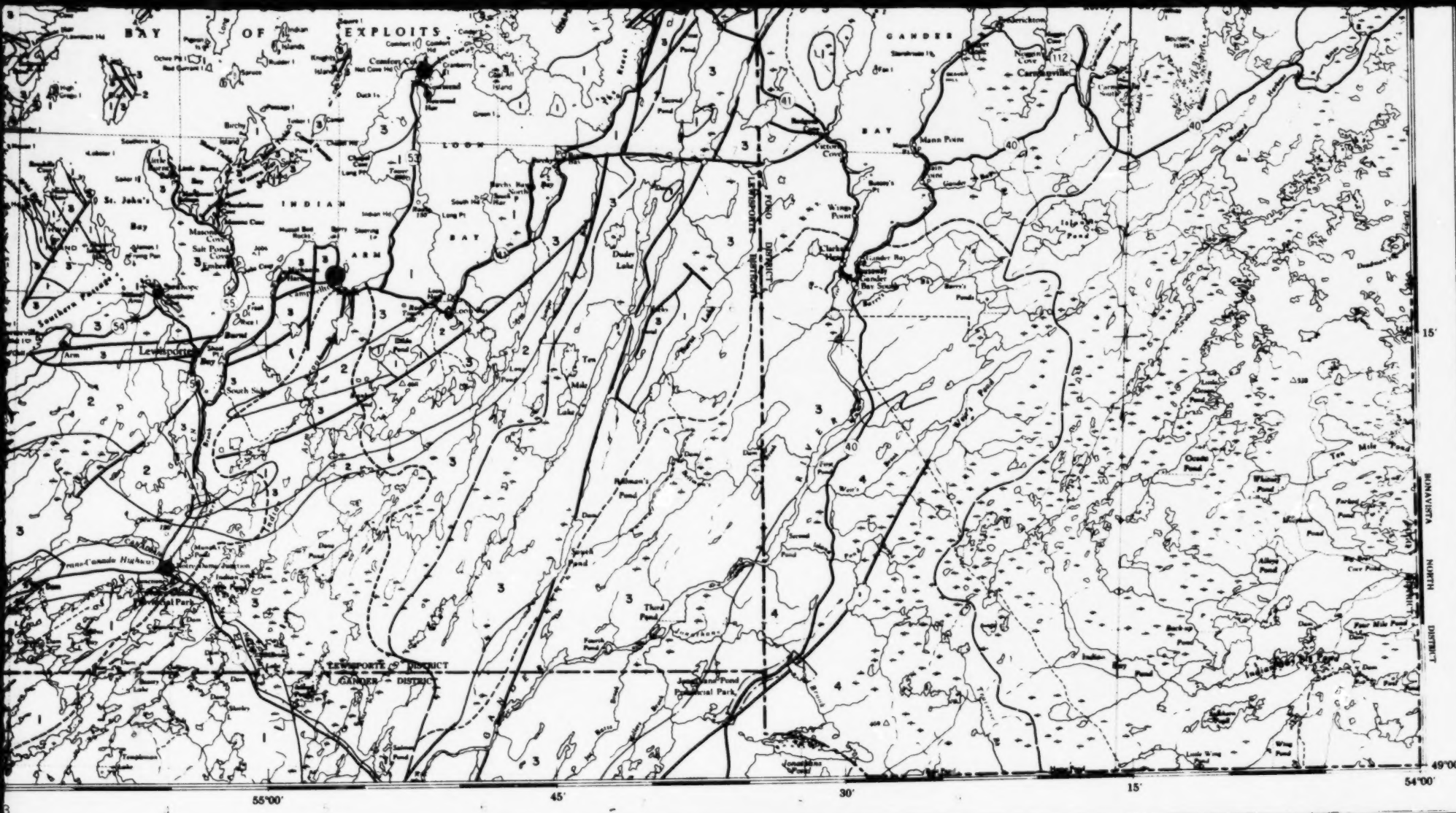
Watershed (Basin) Boundary

Watershed (Sub Basin) Boundary

Fault (defined, inferred)







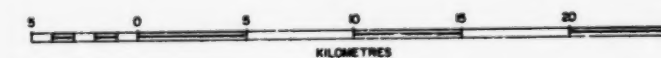
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MAP 3



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